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FISHING METHODS IN LAGUNA DE BAY

By VICENTE C. ALDABA

Of the Bureau of Science, Manila

TWELVE PLATES AND NINE TEXT FIGURES

INTRODUCTION

Laguna de Bay is the largest and probably the most important fishing lake in the Philippines. It has an area of 930.7 square kilometers,[1] excluding Talim Island. It is located in the center of southern Luzon and is only a short distance from the City of Manila. It rises more than 2 meters above sea level, receives drainage from numerous small streams on all sides, and in turn is drained by the Pasig River into Manila Bay. The lake is uniformly shallow, having a practically level floor, which gradually rises to slightly inclined shores around the major portion of the coast.

The littoral districts are well populated and there are good roads all around the lake, except around the Jalajala Peninsula from Pililla to Mabitac, and in Talim Island. The railroad passes near the western and southern shores.

The greater portion of the fish caught is sold in the markets of bordering towns. However, a considerable quantity is taken fresh to the City of Manila, and to San Pablo for consumption by the people inhabiting the interior towns of Laguna Province and the towns of Tayabas near-by.

[1] Pratt, W. E., Philip. Journ. Sci. § A 11 (1916) 223–226.

THE KINDS OF FISHES CAUGHT IN LAGUNA DE BAY

There are only a few species of fishes caught in considerable quantities in Laguna de Bay. *Dalag, Ophicephalus striatus* Bloch; *kanduli, Arius* spp.; and several species of gobies are the most important. *Hito, Clarias batrachus* (Bloch); climbing perch, *Anabas testudineus* (Bloch); *ayoñgin, Therapon argenteus* (Cuvier and Valenciennes); *talilong, Mugil* spp.; *palos, Anguilla* spp.; *buanbuan, Megalops cyprinoides* (Broussonet); and *tagan, Pristis microdon* Latham, are also caught in considerable quantities. Shrimps (Palæmonidæ and Atyidæ), being of considerable value both as human food and as fertilizer to the betel vine, which is extensively cutivated around the lake, should also be included in the list. In this connection mention should be made of the gathering of various kinds of shells to supply certain feed requirements for the extensive duck industry along the coast of the lake.

METHODS OF CATCHING DALAG

The importance of dalag to the people living along the coast of Laguna de Bay is indicated by the fact that there are more different ways to catch it than are used for all other kinds of fishes in the lake. Then, too, most of the apparatus used in capturing dalag is inexpensive, which probably accounts for the greater number of people engaged in fishing for this particular species.

With bare hands.—To capture dalag with the bare hands is not easy. Of all the common species in Laguna de Bay this fish is probably the most shy and energetic. It can jump a long distance and moves through the water very swiftly. Even out of water a dalag of some size is hard to handle. It requires, therefore, a good deal of experience and skill to capture the dalag with the bare hands while it is in the water. Usually only the small ones are caught in this way.

In rice paddies that have been puddled, the dalag is more readily caught because it cannot move so easily through the muddy water.

In certain places in Laguna de Bay during the dry season when the water in the lake has practically reached its lowest level, dalag in large numbers are left imprisoned among grasses and water hyacinths. During this time people catch dalag in quantities with their bare hands. This is especially true

along the grassy shore line of the eastern lobe of Laguna de Bay.

Salacab.—All around Laguna de Bay the *salacab* (Plate 1, fig. 1) is certainly the commonest fishing apparatus. One or more of these traps may be seen under most houses in all the fishing villages, either hanging or standing on the ground. It is handy for any member of the family to take to any creek or to the lake to catch fish with for the next meal. Its main importance, however, lies in the fact that it supplies the market with considerable quantities of dalag. Because in water where this trap is successfully operated dalag is the commonest inhabitant, this fish makes up the major portion of the fishermen's catch.

The size of the salacab most commonly seen around the lake is about one-half meter in diameter at the bottom opening, and a little less than a meter in height. The upper opening is narrower, being just large enough for a hand or a foot [2] to be inserted in order to take out the catch. It is made of bamboo splints about one centimeter in width, tied at regular intervals with split rattan to two or more bamboo, wooden, or iron hoops.

In operating this trap the fisherman holds it with one hand at the upper opening and drives it into the water vertically with sufficient force to embed the lower part in the mud. This performance is repeated until a fish is caught. The fisherman is instantly aware of his catch as the fish, in its attempt to escape, bumps violently against the sides of the trap. A hand is then inserted through the top opening to take the fish out.

Fishing with the salacab on a carabao.—This is an interesting method of catching dalag. The dalag is not disturbed or frightened by a carabao so the fisherman, taking advantage of this fact, mounts a carabao and with a salacab in hand rides around looking for dalag. A shallow place with grass or other kinds of growth is chosen for this kind of fishing. When the exact location of a dalag is determined by the movement of the water and plant growth or by the appearance of its head on the surface of the water, the fisherman promptly dismounts from the carabao and covers the dalag with the salacab. Sometimes the fisherman uses a baited hook to tempt the dalag to show its head. A dalag nest is usually sought for.

[2] The use of the foot will be explained in discussing the methods of capturing kanduli.

Sucob.—This particular net trap is probably a development of the salacab. At least practically the same idea is involved in both. But the *sucob* consists of a net cone mounted on a strong conical bamboo or wooden frame (Plate 1, fig. 2). The lower rim of the frame is often made of a thin iron strip. The frame is about 3.5 meters in diameter at the base and about 1.5 meters in altitude. The net is about 2.5 meters high with a mesh of about 4.2 centimeters stretched. It is usually handled by three men, and operated in water 2 meters deep.

In going to the fishing ground fishermen carry this trap in a banca. One man sitting on the prow carefully surveys the water ahead of him, alert for any movement that may indicate the presence of a dalag school, and if he detects such a school he signals to the two men at the stern who row the banca noiselessly. The watcher throws small stones into the precise spot to be covered by the sucob, the idea being to make the fish stay at the bottom so they can be approached without being scared away. As the banca nears the place indicated, the watcher puts the sucob which is behind him in a ready position, promptly dropping it into the water as soon as the spot is reached, at the same time putting his weight on the trap by sitting on the vertex of the conical frame. The other two men immediately jump into the water and work with their feet, diving at times, to put the lower rim of the net into the mud so that there can be no possible escape for the fish. The man resting on top of the cone frame unties the upper end of the net and allows the other men to get inside the trap to take the grasses and other rubbish out. When this is done they come out of the net before catching the imprisoned fish. They do this by feeling carefully for the fish which, in trying to escape, bulges out the net, thus creating a sort of temporary bag in which it is held. The man gets hold of it, diving if necessary, and takes it out of the net through the top opening.

Dala (*casting net*).—Along the western coast of Talim Island this net is employed in catching dalag. Here the bottom of the lake is sandy and there is no grass to interfere with the sinking of the rim of the *dala*, so that with adequate weights the net can be made to sink fast enough to capture the dalag. The dalag is caught in practically the same way as with the sucob. Usually only two men are needed in fishing for dalag with this gear, one rowing the boat, and the other locating dalag schools and casting the net.

Panteng pukot.—This is a net varying in length from 20 to 100 meters and wide enough to operate in water breast deep. It carries floats but not weights, the bottom line sinking of its own accord. The mesh is of such dimensions that only fish of considerable size are caught. This is used in rivers with very slow current.

The fisherman in spreading the net starts from one bank of the river, crosses it, and then moves parallel to and close to the other bank. The place chosen is a clean portion of a river but always with a more shady and bushy place a little above it. The shaded portion is known to be the hiding place of the fish. To drive the fish into the net, one or more companions of the fisherman beat the water in the shaded place. To enclose the fish within the net, the two ends are brought together by first dragging slowly across the river the portion of the net parallel to the bank until this end meets the other. Further manipulation of the net finally makes it assume the shape of a flattened circle with two distinct parallel sides, the distance between which gives only enough room for the fisherman to walk back and forth with his hands feeling the outside of the net. The fish, being scared by the movement of the man, tries to escape by rushing outward. Thus a temporary pocket is created in the net in which the fish is imprisoned. The fisherman gets hold of the fish while it is in this position.

This apparatus may catch more hito than dalag when there happen to be more of the former kind.

Pukot dalag.—This is also known as *pukot gilid* and *barimbao.* This is a net 200 to 300 meters in length and operated near the shore of the lake in water about 2 meters deep. It carries floats but usually no weights, the lower line, which is of heavy rope, being heavy enough to keep the net close to the bottom. It has a bag, the upper part of the opening of which is held high above the water by stakes, while the lower portion is kept under water as the net is dragged along. When fish are secured in the net the entire opening of the bag is held high above the water. The catch is taken out of the bag with the help of dip nets. The mesh of the bag is about 2 centimeters and that of the dragnet varies from about 3 centimeters near the bag to about 5 centimeters towards the end.

The details of the operation may be seen in fig. 1. As shown in this figure, the banca carrying the men assumes three positions, each of which enables them to pull the net in a line tan-

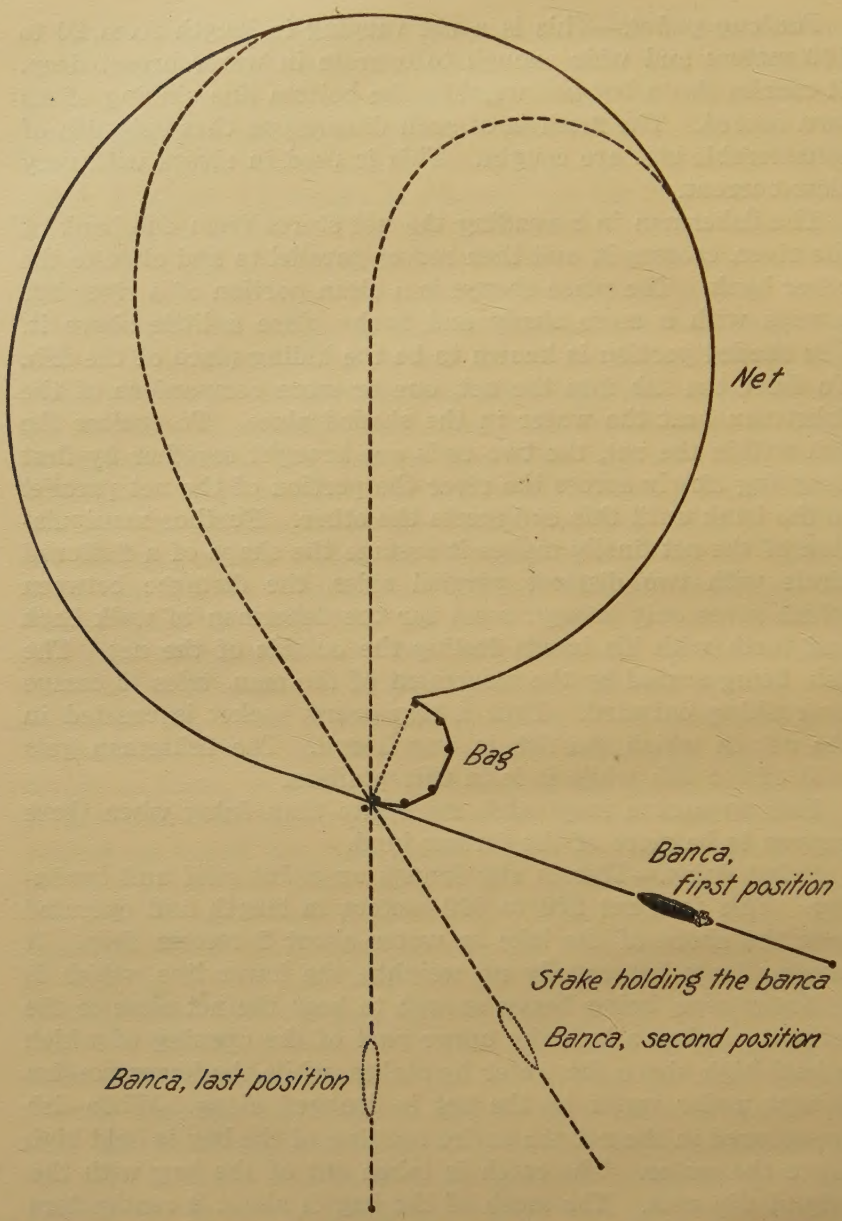

FIG. 1. Diagram to show the positions of the banca, which carries the men, at different stages of pulling the net of a pukot dalag.

gential to the circle formed by the apparatus. These changes in position are necessary to make the work as light as possible.

The catch consists mainly of dalag but some kanduli and gobies are also captured. It should be mentioned in this connection

that a very similar apparatus, the *pukot laot*, operated in deeper parts of Laguna de Bay, catches mainly kanduli and some gobies but practically no dalag, thus showing that the distribution of the dalag is limited to the water near the shore.

Salapang.—This is a spear with barbed iron points varying from three to seven in number. The shaft is from 2 to 3 meters long and is usually made of bamboo. It is used in the night with a strong light by a fisherman who, while watching for the fish, stands in a banca that is rowed by another. This is a common method of catching various kinds of fishes in different places, but in Laguna de Bay it is used mainly for catching dalag.

Alcabus or arcabuz.—This ancient weapon is still effective in catching dalag. It is a strong bamboo bow mounted transversely on a wooden stock (Plate 2, fig. 1). There is a movable pin which holds the string and a trigger to release it. To guide the arrow, which carries several barbed iron wires forming the head, there is a groove in which it rests snugly before the fisherman releases the string to shoot a dalag.

There are two kinds of arrows used. One carries a detachable head; in the other the head is rigidly fixed to the shaft. In the first case there is a string which holds the head to the shaft when the former is detached from the latter, a thing which happens when a dalag is hit and tries to escape.

The effectiveness of this old weapon rests solely on the peculiar habit of the dalag of coming slowly to the surface of the water at certain intervals, at the same time releasing bubbles of air. It is while the dalag is leisurely coming to the surface that the fisherman takes his aim and releases the trigger.

A fisherman usually chooses his position after a dalag nest has been located.

Patucba.—This consists of a small bamboo rod carrying a line with a baited hook and standing in shallow water. The bait is a living frog. A fisherman may have as many as fifty or more of these rods at a time in a place.

Pamitin.—At certain seasons of the year frog baits are hard to obtain and command a high price in the market varying from 20 to 50 centavos a hundred. Many fishermen resort to using a snail, or *cohol, Ampullaria* sp., without the shell. In this case the water where the baited hook is placed is made turbid by stirring it with the hands or feet. The object is to prevent the bait from being nibbled away by smaller fishes, such as

bañgayñgay, Ophiocara aporos Bleeker. Hooks baited and set in the way described are called *pamitin* in the eastern part of the Laguna de Bay region, where they are common.

Palaway.—This is a long line and many short ones; the main line is held tautly above the water by means of bamboo stakes standing at regular intervals. The short lines carrying the hooks are about 0.5 meter long and are attached to the main line at intervals of about 2.5 meters. The bait consists of a living frog held just touching the surface of the water.

This fishing apparatus is known sometimes as *patucba,* but it is generally referred to as *kitang* although *palaway* is the specific term.

Galay consists of a hook of considerable size baited with a frog and suspended by a line about a meter long from a rod 3 or 4 meters in length. A man operates only one galay at a time and he usually fishes for a nesting dalag. Sometimes a man with this apparatus fishes from a banca, usually along a grassy shore line.

Rattan bocatot.—This fishing apparatus is simply a deep pocket made of split rattan in the fashion of a net (fig. 2). The mesh varies from about 2 centimeters square at the closed end to about 5 centimeters square towards the mouth. The length is about 40 centimeters and it gradually tapers towards the closed end. There are four large loops at the opening. In setting, a split rattan which is securely fastened to one loop passes through all the others and is tied to a stake or to a bunch of grass, so that when a dalag, in rushing out of the nest, is caught the *bocatot* not only is not carried away but is closed also. To take the dalag out, the closed end may be opened by loosening a knot. A fisherman may set twenty or more traps of this kind at a time.

It is the setting of the trap that requires experience. The nest of a dalag is first located. Leading to the nest there is a path from the deeper water. The trap is set along the path, near and facing the nest. Grasses or other materials are placed around the nest to close all other possible avenues of escape. The dalag in coming to the nest has to pass by the outer side of the apparatus. When, however, the fisherman approaches the nest, the dalag rushes out to a place of safety towards the deeper water, and in so doing it naturally follows the old path only to land in the trap.

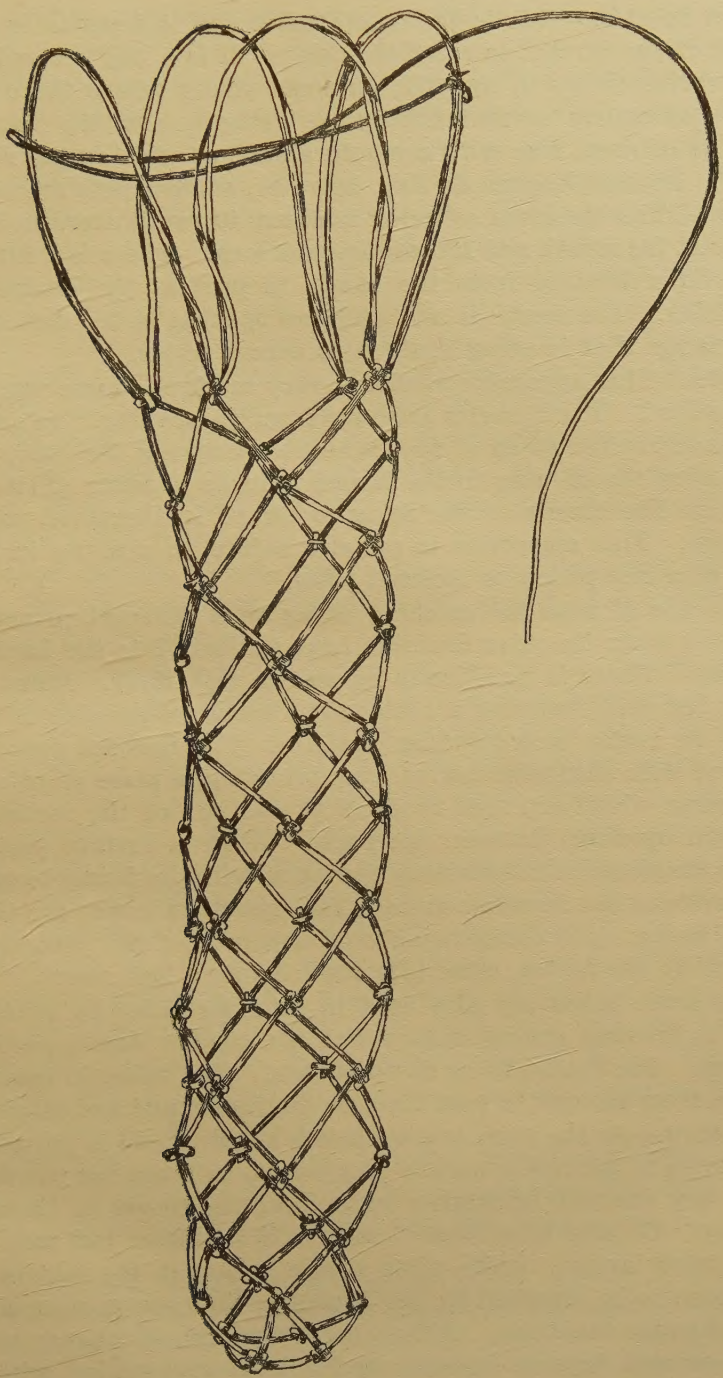

FIG. 2. Rattan bocatot.

Net bocatot.—This is the true bocatot and it depends on the speed of the current to catch the dalag. It is a bag net and its size varies (Plate 2, fig. 3). In some places where there are rivers of strong current during the dalag season, the bocatot may be of great size with a mouth almost as wide as the river itself. Around Laguna de Bay, however, smaller nets are commoner. The specimen collected is about 40 centimeters in diameter at the mouth and 190 centimeters long. There is a funnel at a little distance from the mouth to prevent the escape of the dalag. The mouth is set before an opening in the dam of a rice paddy that is being drained of excess water.

Bobo.—This apparatus works in very much the same way as the bocatot. The funnel is quite far from the opening. In order to accelerate the speed of the current on entering the *bobo,* the part from the opening to the funnel is made to taper (Plate 2, fig. 2). The chance of the dalag to escape is, therefore, much reduced. This apparatus is set also before an opening in the dam of a rice paddy or isolated pools.

The use of bobo for catching dalag on a different principle is found along the river draining Lake Calibato into the Laguna de Bay. There is practically no soil in this river. Dams of rocks are built inclosing a rectangular space on the side of the river, its rocky bank forming one side. The inclosed space is covered with coco-palm leaves, thus providing a place of retreat for dalag which are free to come in and out of the inclosure through openings between the rocks. After a certain period, bobos are placed in holes among the rocks, with the funnel toward the inside of the dammed space. The coco-palm leaves are then taken away. The dalag being thus deprived of the protection offered by the leaves, come into the bobo as a last resort.

The same bobos are also used in catching dalag by putting them in crevices among rocks which are piled to dam a part of a river. The funnel faces down stream. The dalag in coming up the river attempt to pass through the funnel and are caught.

Bonbon.—As the name implies this is simply a pile of branches and twigs to provide a sort of playground or home for the fish. It is very common in shallow water near the shores of Laguna de Bay. Usually it is about 3 meters in diameter but may be very much larger. Quite often a hole is dug in the middle of the space to be occupied by the *bonbon.* This serves as special attraction for the dalag. After a certain period, which may vary from several days to several weeks, it is surrounded with a

baclad,[3] the branches and twigs thrown out and the fish caught with a salacab (Plate 3, figs. 1 and 2).

Floating patches of water hyacinth.—This introduced water plant, *Eichornia crassipes* (Martius) Solms which has been the cause of so much regret on account of the inconvenience it is causing to shipping and fish corrals, is becoming, at least in one way, a blessing to the fishermen. It has been found that dalag and other fish are attracted to stay under the shade of these plants. Fishermen gather and maintain these plants in regular patches and now, especially along the shore from Angono to Binangonan, they may be seen at more or less regular intervals. At other places, bamboo inclosures with a few plants inside may also be seen, the evident object of the owners being to fill them up in due time with fresh collections, and failing in this, to allow the plants to multiply. It may be said, therefore, that the water hyacinth has now come to be cultivated (Plate 3, figs. 3 and 4).

After certain periods these patches are surrounded with baclad, the plants temporarily taken out, and the fish caught with the help of a salacab.

Pugad-pugad.—As the name implies, this is a sort of nest and may be seen floating by the hundreds in some parts of Laguna de Bay, especially along its northeastern side. It is constructed of a coarse-woven bamboo for the floor, on which is built a wall of grass and mud, making the whole affair as nearly ideal as possible for a retreat for dalag. At the side, just a little below the surface, is a small door through which the dalag enters. The roof consists of a thin straw covering.

A necessary part of this fishing apparatus is the *panaclob* which is a bag net with a strong frame. As the fisherman in his banca approaches the *pugad-pugad* quietly, he covers it on top with the panaclob, and at the same time with one hand he prevents the exit of the dalag through the side door. The dalag jumps through the thin roof to escape and is caught in the bag net (Plate 4, figs. 1 and 2).

Pangloob.—This fish trap is found almost anywhere around the lake in different forms, but in all cases there is a door closed by a trigger which is so placed that the dalag comes in contact

[3] A baclad is made of bamboo splints usually from 0.5 to 2 centimeters wide and from 1 to 10 or more meters long, held together in parallel order by split rattan or other materials so as to form a sort of a matting. The term baclad is also used to mean a fish corral as a whole.

with it on entering the trap. In rivers, the *pangloob* is constructed by making a sort of dugout in a shaded portion of the bank (Plate 5, fig. 1). In shallow water it is made of coarse-woven bamboo set on the mud (Plate 5, fig. 2). In deep water the pangloob is a trap complete in itself and floating on the water (Plate 6, fig. 1).

Loóng.—This is essentially a hole in the ground under shallow water or along the banks of rivers, provided with branches and twigs and water plants of various kinds to attract the dalag. The hole is about a meter in diameter and less than a meter deep. The embankment is a little above the water surface. The details of the construction are shown in fig. 3. The back part of the hole is dug a little deeper than the rest, and it is here the dalag is expected to make its nest. When eggs are laid the fisherman catches the fish with a galay, or a salacab.

These traps are constructed mostly during the beginning of the rainy season when dalag are laying eggs; that is, from June to August. A fisherman may have as many as twenty of these traps at a time. As the water in the lake rises he makes new holes towards the shore.

Paluksó.—This is set up in a creek or river when the water in the lake is subsiding (fig. 4). It consists of two wings and a heart, just like an ordinary fish corral in a river, and in addition there is a platform on which the dalag land on jumping out of the water, and a live box to keep the dalag alive until the fisherman comes to collect them. To prevent the dalag from escaping, the wings and the heart rise high above the water except a part about 1.5 meters wide at the back of the heart which is only a little above the water. This part instead of being vertically set is at an angle to the surface of the water, with the lower end against the current and in contact with the bottom. As the dalag travels downstream it meets this inclined part of the heart. Either it changes its course and turns around along the side of the heart, or attempts to continue its voyage by jumping out of the heart. In the first case it is likely to continue turning around, until it finally attempts to escape by jumping out on striking the inclined back part. In the second case, jumping at this place would make the dalag land on an oppositely inclined platform which is surrounded by high fencing, thus preventing the escape of the fish. The lower side of this inclined platform is tilted at one corner which is maintained a little below the water all the

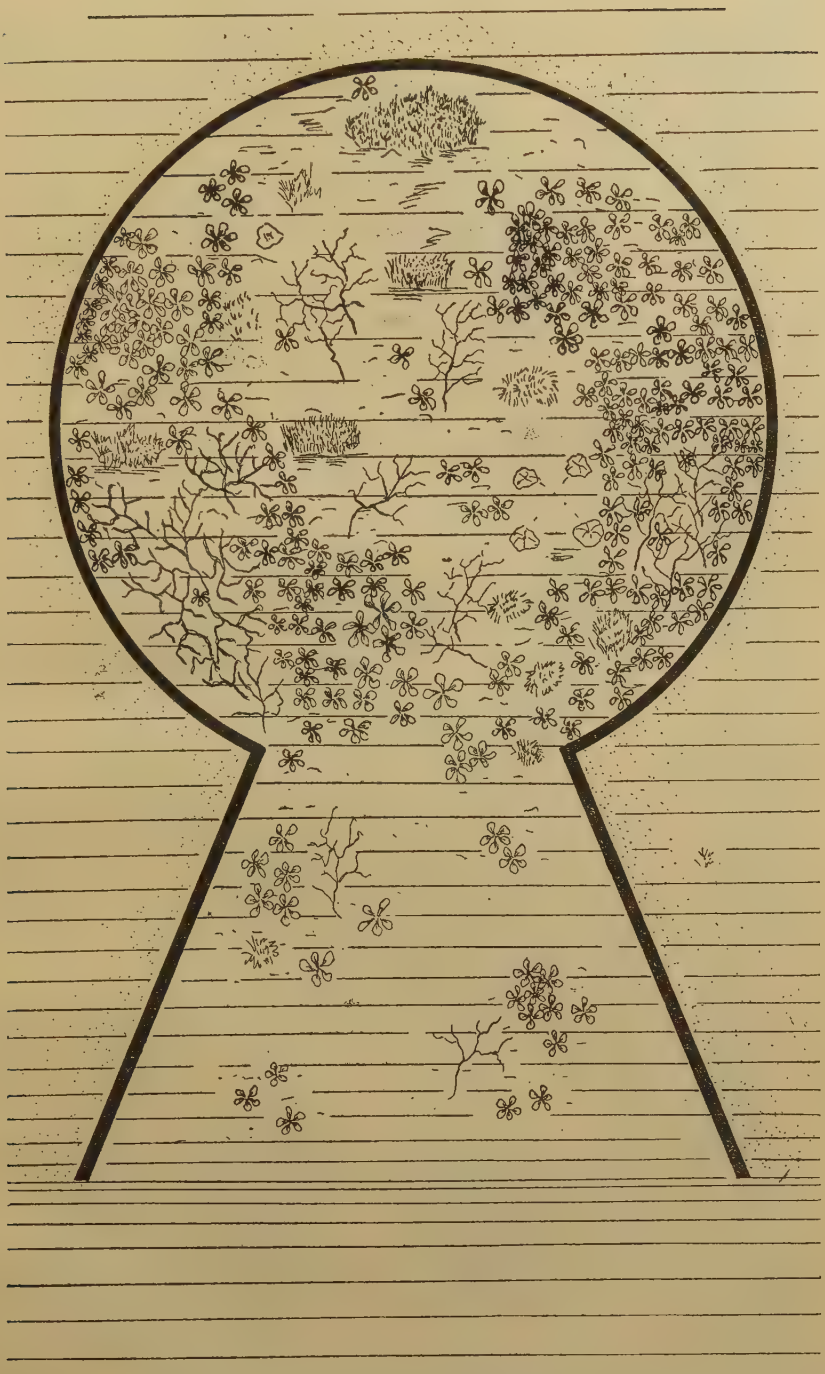

FIG. 3. Diagram to show the construction of a loóng.

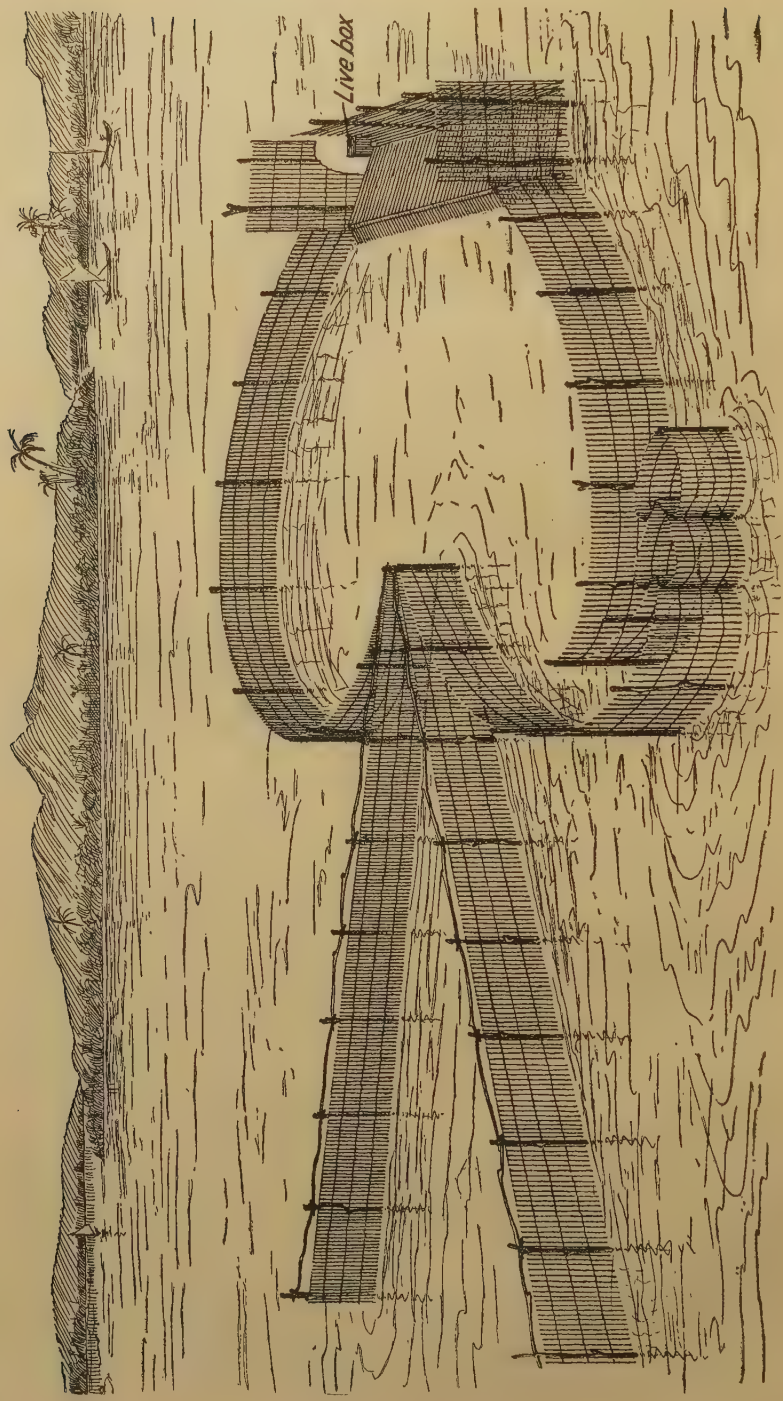

FIG. 4. Paluksó.

time. The dalag is therefore bound to go to this corner. The live box is so placed that its small side opening just fits the corner below the water. The dalag is thus very ingeniously led into the live box. This has a lid on top which the fisherman opens when he comes to collect the fish with a dip net.

In some cases a small heart is provided for by the side of the first one. The object of this is to trap those dalag which fail to jump onto the platform.

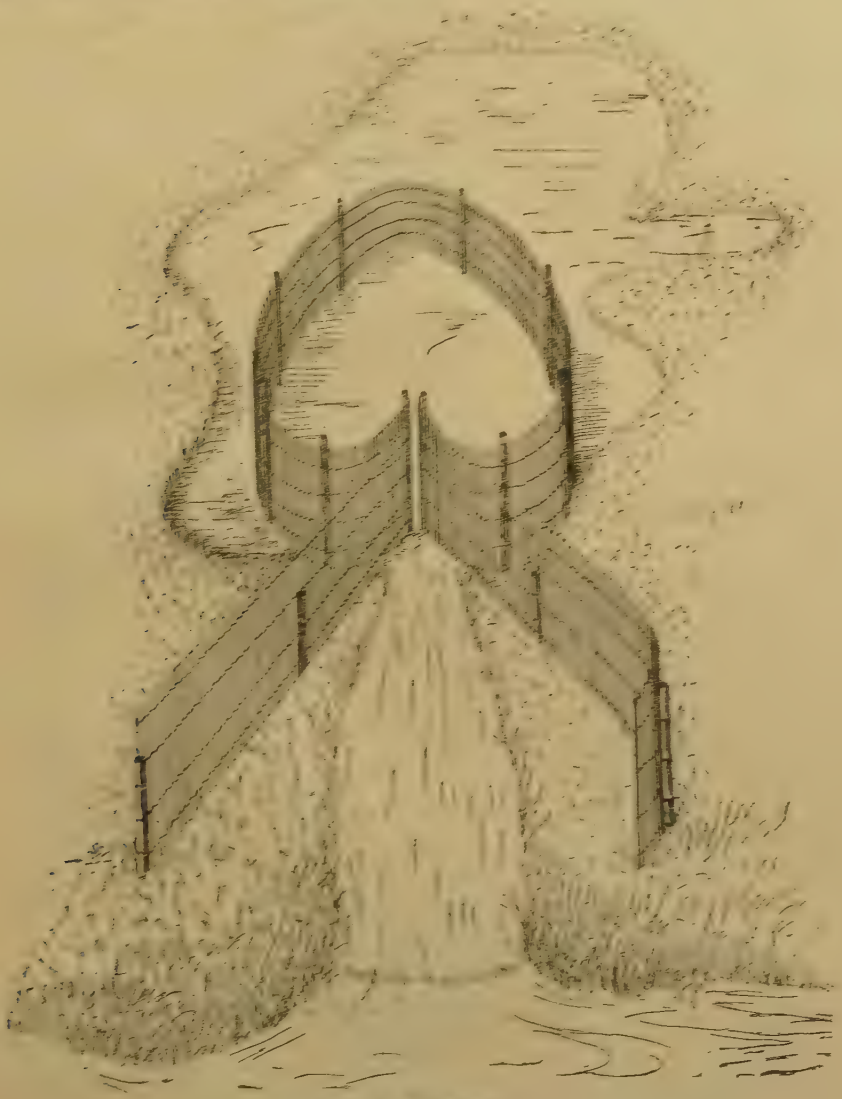

Fig. 5. Pasadsaran.

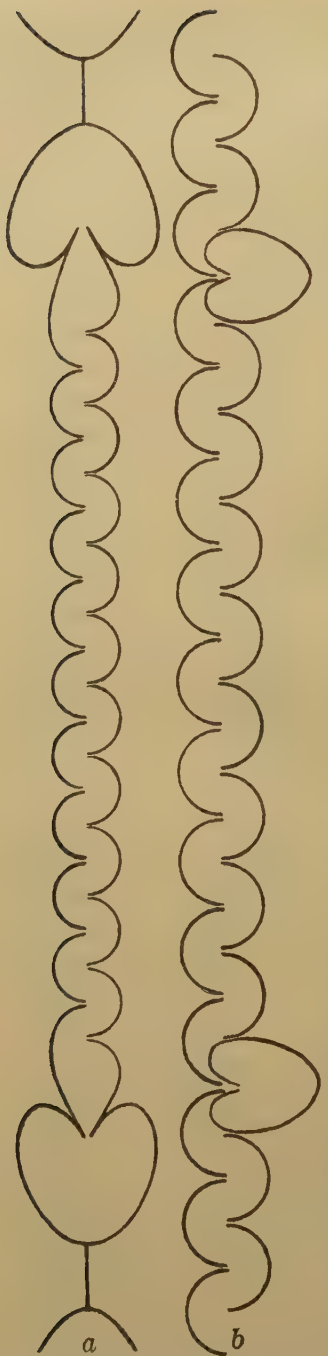

FIG. 6. Diagram, *a*, to show the setting of the kilo-kilo and, *b*, another form of the kilo-kilo.

Pasadsaran.—When the heavy rainy season sets in, that is during June or July, the dalag show a strong tendency to go up the shore. This is the time when the *pasadsaran* is constructed. This is simply an ordinary fish corral in construction having two wings and a heart, but radically differs from the latter in position since its wings face away from the shore (fig. 5). More often, however, the pasadsaran is constructed by first digging a canal less than a meter wide on the shore to allow the water from the background to flow through it to the lake. The dalag going up through this canal are then caught in the pasadsaran set in the canal.

Kilo-kilo.—This trap is a very ingenious device for catching dalag. It is placed across the mouth of a small shallow indentation which is covered with *tikiú, Scirpus grossus* Linnæus, f., or other growths. It consists of baclads, each about a meter long, or less, and placed on the ground in a semicircular position, overlapping each other so as to form a sort of chain. At intervals of from seventeen to twenty-three baclads there is a heart over a meter in diameter. There may be as many as thirty-five hearts in one *kilo-kilo.*

As may be seen from the diagrams (fig. 6), the opening between two semicircles is an entrance. Fish coming from the lake towards the indentation or vice-versa will, therefore, find their way into the trap through one of these many openings and finally land in one of the hearts.

Takilis.—This consists of several baclads joined so as to make a long

one and set up in a more or less semicircular form before a shallow place covered by such growths as ordinary grass or water hyacinths. Several men, each with a long pole, drive the fish from among the grass towards the baclad. As the men approach the two ends of the baclad, the semicircle is gradually narrowed near the middle of the arc until a sort of heart is formed, or the whole semicircle may be narrowed into a small circle. Then the inclosed fish are caught by means of salacab.

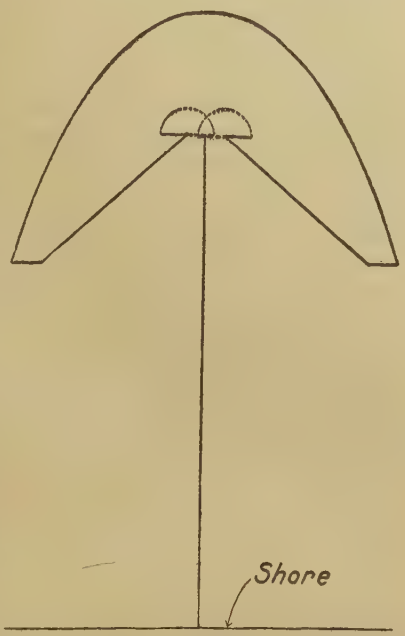

FIG. 7. Diagram to show the construction of saklitan.

Saklitan.—This is a simple corral with a leader starting from the shore and a big heart. The opening of the heart is provided with two aprons which serve as gates that are closed when the dalag inside the heart are being caught (fig. 7). This corral which is mainly found along the northwestern shore of Laguna de Bay is put up during the rainy season when the dalag tend to come towards the shore. As the dalag approach the shore line, being unable to progress any further, they move along the shore, hit the leader of the *saklitan* and follow it until they land in the heart. Naturally, as the water in the lake rises, the saklitan has to be moved towards the shore. To catch the dalag in the heart the fishermen use a rectangular drag net about 1 by 4 meters provided with a bag about 2 meters deep. A pole at each end serves as a handle and keeps the net stretched vertically.

Salap.—This is a dip net which is used more for catching shrimps and is, therefore, properly described under that heading. During certain months of the year, especially July, August, and September, when dalag fry are abundant the *salap* is used in catching them. The dalag fry remain in swarms for some time and it is then that the fisherman may scoop up practically all of them with a salap, to be either cooked for food or used as baits for kitang in catching kanduli.

METHODS OF CATCHING HITO

This species is included with the dalag and the climbing perch in the popular group known as mudfish; but while the dalag is an energetic animal, the hito is a sluggish one. It is caught with the dalag by the bobo and the panteng pukot and will take the hook also.

Salacab.—Like dalag, hito are caught by ordinary salacab singly. But hito come together in quite large numbers at times, apparently in play. To catch them while together a big salacab 1 meter in diameter at the base and about 0.75 meter in altitude is employed.

Sucob.—Another apparatus used for catching hito while they are together is the sucob, very similar to that used for dalag but smaller.

Siid.—A very interesting trap for catching hito exclusively is the *siid,* also called *bakikong* (Plate 6, fig. 2). This method of catching hito is best developed in the eastern side of Laguna de Bay, although it is also employed in other places.

FIG. 8. Diagram to show the outline of the siid and the position of the bait.

This is a small affair and a fisherman may have as many as fifty at a time set at different places in grassy and shallow water. It is made in the shape of a heart (fig. 8). As may be seen from the diagram, before reaching the real entrance into the heart, there is another entrance formed by two aprons. There is neither leader nor wings. The hito is attracted to this trap by means of strong smelling baits. The recipes for baits vary, and in many instances they are guarded as individual secrets.

Here are two recipes:

1. Staranise, *Illicium verum* Hooker, f.; cinnamon, *Cinnamomum zeylanicum* Blume; clove, *Eugenia aromatica* Baillon; and nutmeg, *Myristica fragrans* Houttuyn, are fried till they are crisp, ground and mixed with coconut oil to make up the stock solution. Living white ants (termites) and snails are ground and, with a quantity of the stock solution, mixed with ground clay and formed into a ball about the size of a fist. This is placed at the mouth of the heart.

2. Nutmeg, the roots of *lobigan, Acorus calamus* Linnæus; *mutha, Cyperus rotundus* Linnæus; and seeds of *Ricinus* are roasted and ground together and mixed with ground white ants, ground clay, and milk from grated coconut meat. A fist-sized ball of this mixture is placed at the mouth of each siid.

Pante.—This is practically similar to that used in catching kanduli (see below) but smaller in dimensions, being operated only in the shallows near the coast. It is commonly met with on the eastern shore of Laguna de Bay.

METHODS OF CATCHING KANDULI

Kanduli is caught in the deeper regions of Laguna de Bay. The apparatus intended to catch this fish are, therefore, so constructed that they can be operated in deep water.

Salacab.—The salacab is used also for catching kanduli. Since kanduli live in deeper water, the salacab is used a good deal below the surface. Indeed, men fishing for kanduli with salacab work in water breast or neck deep. The operation of the salacab in catching kanduli is much the same as in catching dalag. However, when a kanduli is felt inside, one foot instead of a hand is inserted slowly through the upper mouth of the salacab and the kanduli carefully and firmly pressed down under the foot against the mud so that it cannot move. Then, with a single pronged spear about a meter long, including the handle, the kanduli is transfixed, the spear passing between the toes of the fisherman.

Pukot laot.—This is the most expensive of all fishing gears in Laguna de Bay, some of them costing as much as 2,000 pesos. It is a pukot dalag on a much larger scale, and catches kanduli instead of dalag for the simple reason that the latter fish is limited to the shallower water near the shore. Some pukots are 2,000 to 3,000 meters long and wide enough to be operated in any part of the lake. From thirty to fifty men are employed in the handling of this net. Of these, about twenty pull the net, and four or more dive to see that the bottom line is in good contact with the bottom or buried a little in the mud. The rest collect the net into the banca, or do other things.

During the spawning season, from February to May, inclusive, it is said that kanduli do not move much, and this is the time when big catches are expected. A kanduli school is not readily located, but birds sometimes give indications of its presence.

Aside from kanduli, *biang puti, Glossogobius giurus* (Buchanan Hamilton) are also caught in large quantities.

Pante.—This is a gill net and is the commonest net gear that is found around Laguna de Bay. It is provided with floats but carries no weight, the bottom part of the net sinking of its own accord. Depending on its length, which may be 1,000 meters, although it is usually less, one or more men are required to operate it. It is always wide enough to leave a good margin lying on the bottom when set. This provision is necessary because kanduli stay at or close to the bottom. The mesh is about 5 centimeters stretched. The *pante* is allowed to drift with the current and is usually operated in the night.

A very recent development is a pante having a 10-centimeter mesh. Naturally, only big kanduli are caught. The pante is sometimes placed in water in a more or less circular form, and the fish are driven to the net by beating the water from the center. This is usually operated in the day time.

Tilay.—This is simply a hook and line, but its use for catching kanduli requires experience and patience. A banca of special make, that is, one with an angular bottom instead of an ordinary flat one, is employed. The object of the angular bottom is to avoid the noise which a flat one makes against the waves. A small paddle with a short handle operated with one hand is employed, the other hand being left free to manipulate the line.

The baits consist of living young kanduli a few centimeters long. These are placed in water under the fisherman's seat, so that when he needs one he does not have to move about and create noise to get it. He uses a small dip net to get a bait.

The fisherman takes advantage of the wind and drifts slowly with it while fishing.

Kitang.—This is a trawl line carrying at times from two to three thousand hooks suspended from it by short lines about two-thirds of a meter long and one and one-third meters apart. Among the baits used are shrimps, small crabs, ayoñgin, bañgayñgay, earthworms, snails, and the small bulbous petioles of water hyacinth (Plate 7, figs. 1 and 2).

A man engaged in kitang fishing has to have other fishing apparatus also for getting the baits. He may have a number of bonbon that would give him daily enough shrimps for baits; or a *sakag* to catch ayoñgin. Several kitang fishermen may work together and combine their trawl lines. They may then

catch bañgayñgay, small kanduli, and others with a *sikit,* which is a sakag and a long chain requiring several men to operate.

Casting net.—This net is also used for catching kanduli. Usually three men go together to fish with this apparatus; two row the banca while the third manipulates the net, observes the movement of the fish, and throws stones to the spot to be covered by the net. The object of throwing stones is to make the fish stay at the bottom and to direct the course of the boat. The net is slowly lifted out of the water and the catch taken into the banca.

Sakag.—This fishing gear is primarily for catching ayoñgin and is, therefore, properly described under that heading, but at times large quantities of young kanduli are caught with it.

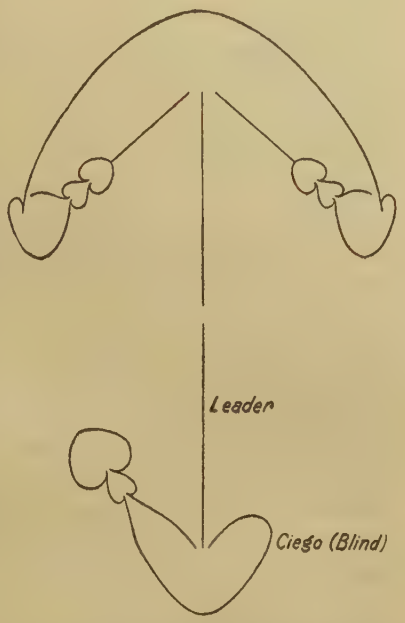

FIG. 9. Diagram to show the construction of a fish corral in Laguna de Bay. Usually the unsymmetrical head known as ciego (blind) is omitted. The ciego is said to catch more fish at the beginning of the rainy season, because at that time the fish move towards the shore.

Fish corrals.—These are numerous in Laguna de Bay and when located in deeper water catch kanduli mainly (Plate 8, fig. 1). In ground plan they are mostly of the type shown in the diagram (fig. 9). The leader is perpendicular to the shore line. In some places the corrals are arranged in series starting from near the shore and varying from several to twenty or more in each series.

METHODS OF CATCHING GOBIES

The most important of the gobies caught in Laguna de Bay is the biang puti. The *dulong, Mirogobius lacustris* Herre, is caught in large quantities during the rainy season.

Bobo.—The practice of catching biang puti by means of the bobo prevails in many places around the lake, but in Cardona, Rizal Province, both the catching of the fish and the

manufacture of bobos have become quite an industry. Here the bobos are made in large numbers and placed at the bottom of the lake. They can be bought at a very reasonable price, around 15 pesos a hundred. The maker also sets the bobos in the water for any fisherman at about 20 pesos a hundred, including the cost of the bobos themselves.

The bobo is made of woven bamboo shaped much like the ordinary jar or demijohn without the spout. It is about 60 centimeters high and about 35 centimeters at the widest diameter. To the uninitiated, bobos piled by the roadside, which is a usual sight in Cardona, appear like so many demijohns, each inclosed in wickerwork (Plate 9, figs. 1 and 2; Plate 10, figs. 1 and 2).

These bobos are placed at the bottom of the water, about a hundred at a time, securely attached to a long vine of *hinggiú, Ichnocarpus volubilis* (Loureiro) Merrill, about 2 meters apart. The fisherman uses a triple-hooked iron rod (Plate 8, fig. 2) in bringing the main line to the surface of the water in order to look into each bobo for imprisoned gobies.

Pante.—This is a drifting gill net with a mesh of about 5 centimeters stretched and usually of No. 40 cotton thread. It is kept soft and white by being treated with white of duck eggs and then steamed. After this treatment the net is resteamed after using it the second and fourth times, and after the sixth time it is again treated with white of eggs and steamed.

Pandulong.—During the rainy season large quantities of dulong appear near the shore. The fisherman builds a leader from the shore consisting usually of leaves of coco palm or banana tied to a series of bamboo stakes in a straight line. The more permanent ones are strongly built of large bamboo stakes and woven pieces of bamboo instead of coco or banana leaves. The dulong in their movement along the shore follow the leader, at the end of which they are collected in large numbers into a salap.

Sikit.—This apparatus consists of a sakag and a long iron chain or a rope to which are tied dried banana leaves. The sakag is set up and supported by stakes. Then, starting from a distance, the chain is dragged towards the sakag by two men each holding an end. The sakag is then lifted and the catch collected, and another place is chosen to repeat the same operation.

The catch consists mainly of baŋ̃gayŋ̃gay.

In many cases this apparatus forms a unit with the kitang and is used only to catch baits for the latter.

METHODS OF CATCHING AYOÑGIN

Ayoñgin is not a highly prized fish, being small and possessing stiff bones, but its abundance at times in some localities has made it popular among the poorer class. When small, about 2 or 3 centimeters in length, it serves as bait for kitang. Ayoñgin go in schools on the surface of the water and are, therefore, readily located by fishermen.

Hook and line.—A considerable quantity of ayoñgin are also caught, usually by women who use hook and line with a rod about 2 meters long. The bait consists usually of pieces of fish, shrimps, and earthworms.

Sucob.—The sucob that is used to catch ayoñgin is quite similar to the one used for capturing dalag, but it is much lighter and has a long handle which is the projection of the vertex of the cone. It catches the ayoñgin by the gills as they rush out after being covered by the sucob. Those that escape being caught by the gills in the net are captured in the temporary bag formed by the side of the frame when the trap is lifted (Plate 9, fig. 3).

Sakag.—In shallow water this net is held by one person in a place, while one or two others walk from a distance and drive the ayoñgin into it. The sakag is lifted to collect the catch and then another place is chosen. Sometimes one or two men may push this apparatus to catch the fish (Plate 11, figs. 1 and 2). In deeper water the fishermen, usually three in number, go in a banca, two rowing and one handling the sakag. Small kanduli in large quantities are also caught by this method of fishing, especially during the beginning of the rainy season.

Corral.—In shallow places near the coast, with water 1 to 2 meters deep, corrals are constructed mainly to catch ayoñgin. In ground plan the corral is just like any other corral. This fish corral is sometimes known as siid, though differing from the true trap of this name.

METHOD OF CATCHING TALILONG

Pante.—The pante for talilong is kept soft and white by treating with white of duck eggs and then steamed like that for biang puti. The net, however, is of lighter thread and finer mesh.

METHOD OF CATCHING SAWFISH

This fish is caught in the deepest parts of Laguna de Bay, especially in the strait between Morong Peninsula and Talim Island, and the deep between Talim Island and Jalajala Point. A pante, made of heavy twine and having a mesh of about 46 centimeters stretch, is used. Only a few fishermen are engaged in this kind of fishing.

METHODS OF CATCHING SHRIMPS

The small shrimps caught in Laguna de Bay, while not the kind that find ready acceptance among the more-prosperous class, nevertheless form an important source of animal food on account of their abundance and the ease with which they are caught. Large quantities of shrimps, mainly of the families Atyidæ and Palæmonidæ, are used as fertilizer for betel plants, *Piper betle* Linnæus, which are extensively cultivated in some parts of the Laguna de Bay region, and also as feed for the domesticated ducks.

Salap.—Shrimps, mainly of the smaller kinds are fond of staying in weedy places, especially in water with a good stand of tikiú. To gather shrimps in this environment the salap is employed.

There are two kinds of salap. One is a dip net of about a centimeter mesh or finer, mounted on a circular bamboo frame with a short handle (Plate 12, fig. 2). The opening of the frame is about 120 centimeters in diameter and the net itself is about 1 meter deep. The other consists of a net of fine mesh or of sinamay mounted on a rigid triangular bamboo frame or on only two pieces of bamboo crossed near one end. The last two are sometimes handled by two men or women. The fisherman walking along a shallow place near the shore or standing in a banca, if the water is deep, applies the edge of the salap against the sedge. He lifts the salap out of the water every now and then to put the catch in the basket or in the banca. In the rainy season shrimps in considerable quantities are caught with salap even in water without plant growths. In the night, lights are used to attract the shrimps. In this case a light is suspended at the end of a stake and a man or woman pushes a salap around near the stake; or there may be a leader at an oblique angle to the shore and the light is placed at the end towards the shore where the shrimps are caught with a salap.

Bonbon.—In shallow water not inhabited by water plants, fishermen have conceived the idea of providing homes for the shrimps in the form of bonbons. The bonbon consists of twigs of various kinds of trees bundled together and placed under the water (Plate 12, figs. 1 and 2). When the fisherman comes around, he lifts the bonbon and inserts a salap beneath it before it comes above the water. The shrimps fall into the salap.

Bonbon fishing for shrimp is an extensive industry in some parts of Laguna de Bay, and the making of bonbons is an occupation engaged in by some people. The shrimps caught are mainly the larger species (*Palæmon*), which are sold for human consumption.

METHODS OF CATCHING CRABS

Crabs are caught in quantities by using baits of *tikitiki*, copra meal, cooked rice or meat in streams emptying into the lake. Jute sacks with a circular frame at the mouth, pots or tin cans are used for traps. The crabs are used as baits for kitang, besides being eaten by people living around the lake.

FISH POISONS

In Laguna de Bay fish poisons are evidently not much used. The collecting and preparation of the poison material, the uncertainty of catching enough fish to pay for the trouble, the undesirability of the fish caught, because usually dead, and the fact that it is forbidden by law, all contribute to the unpopularity of the method.

But once in a while, especially during certain seasons when fish are plentiful near the shore, fish poisons are employed. There are several fish poisons known among fishermen around the lake and the use of these is many times shrouded with superstition. Probably the best known of these fish poisons is the *palis, Callicarpa cana* Linnæus. The leaves are ground and spread on the surface of the water. *Bayag-usa, Gardenia curranii* Merrill and *hanumi, Diospyros multiflora* Blanco are known for their fruits which are powdered and spread on the water surface.

THE COLLECTION OF SHELLFISH AS FEED FOR DOMESTICATED DUCKS

The extensive duck industry around the shore of Laguna de Bay is dependent mainly upon the availability of shellfish in the lake. The duck's tendency to lay eggs is known to be

very sensitive to changes in the quantity and quality of feed and regularity of feeding. Duck tenders say that even the localities from which the shells come have a marked influence on the egg-laying capacity of the ducks. Often the shells are cooked before feeding.

It is estimated that a duck consumes about 1 to 1.5 liters of shellfish a day, so that a flock of a hundred will keep a man busy gathering shells every day or every other day.

To gather shellfish from the bottom of the lake a man stands in a banca and, holding the handle of the scraper with two hands, scrapes the bottom of the lake, (Plate 11, figs. 3 and 4). In some cases the scraper, heavily weighted and attached to a rope, is dragged along the bottom from a moving sailboat. Mainly *suso, Vivipara angularis* Müller; *sambuele, Melania* spp.; and *tulla, Cyrena* (*Corbicula*) *manillensis* Philippi are obtained.

Usually attached to various kinds of water plants are the cohol, and *anod-anod, Amphipeplea* sp. These are gathered with the help of a small dip net.

The tulla and the cohol also serve as human food, and the latter is used as bait for dalag and kanduli besides.

ILLUSTRATIONS

PLATE 1

FIG. 1. Two men on their way to the fishing grounds. The man on the left carries the fishing accessories, which consist of two salacabs, one inside the other, and two creels.
2. Sucob for dalag being carried on a banca. The part of the net above the vertex of the conical frame is tied into a knot.

PLATE 2

FIG. 1. Alcabus.
2. Bobo for dalag.
3. Small net bocatot.

PLATE 3

FIG. 1. Bonbon for dalag, close view.
2. Bonbons for dalag. In the background are fish corrals.
3. Floating patches of water hyacinth under which dalags are fond of staying.
4. Close view of a floating patch of water hyacinth.

PLATE 4

FIG. 1. Pugad-pugad.
2. Pugad-pugad being visited by the owner. The panaclob is just being taken off showing a dalag caught in the net.

PLATE 5

FIG. 1. Pangloob in a river bank.
2. Pangloob set on mud with the door taken away. In the rainy season the major portion of the trap is under water and it may then catch dalag.

PLATE 6

FIG. 1. Floating pangloob among growths of baino (*Nelumbium nelumbo*).
2. Siid in position.

PLATE 7

FIG. 1. Fisherman rearranging the hooks of his kitang after fishing.
2. Drying the kitang.

PLATE 8

FIG. 1. Fish corral in Laguna de Bay showing the leader and the left side of the head. The stakes and the ropes show the presence of bonbon for shrimps.

2. Triple-hooked iron with a long cabo-negro rope. This instrument is dragged along the bottom of the lake to locate and bring to the surface the main line to which are tied in a series a number of bobos, in order that the imprisoned gobies may be collected.

PLATE 9

FIG. 1. Bobo for goby (*Glossogobius giurus*).

2. Bobo for goby with the bamboo stopper off.

3. Sucob for ayoñgin.

PLATE 10

FIG. 1. Man of Cardona making a funnel for a bobo. Note the revolving conical block of wood on which he is building the funnel.

2. Same man building up the main body of the bobo on a finished funnel.

PLATE 11

FIG. 1. Pushing a sakag.

2. Lifting a sakag in order to take out the catch.

3. Scraping the bottom of the lake for shellfish.

4. Putting the shellfish into the banca.

PLATE 12

FIG. 1. Stakes to each of which is tied a bonbon for shrimps. In taking the bonbon to the surface of the water the fisherman pulls the rope.

2. Fisherman collecting the shrimps from a bonbon by taking it out of the water, placing a salap beneath before it comes above the surface.

TEXT FIGURES

FIG. 1. Diagram to show the positions of the banca, which carries the men, at different stages of pulling the net of a pukot dalag.

2. Rattan bocatot.

3. Diagram to show the construction of a loóng.

4. Paluksó.

5. Pasadsaran.

6. Diagram, *a*, to show the setting of the kilo-kilo and, *b*, another form of the kilo-kilo.

7. Diagram to show the construction of a saklitan.

8. Diagram to show the outline of the siid and the position of the bait.

9. Diagram to show the construction of a fish corral in Laguna de de Bay. Usually the unsymmetrical head known as ciego (blind) is omitted. The ciego is said to catch more fish at the beginning of the rainy season, because at that time the fish move towards the shore.

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PLATE 1.

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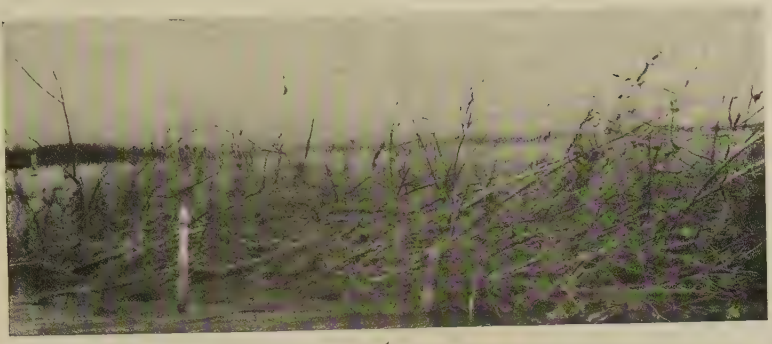
PLATE 2.



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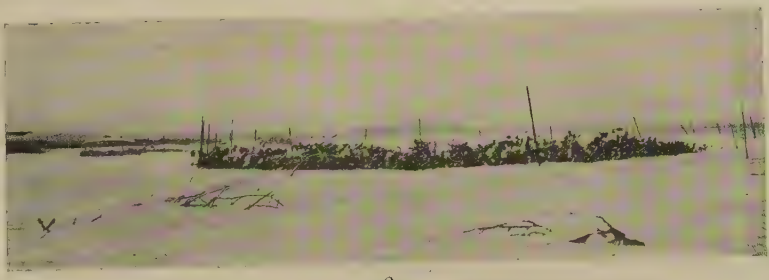

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PLATE 3.

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PLATE 4.

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PLATE 5.

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PLATE 6.

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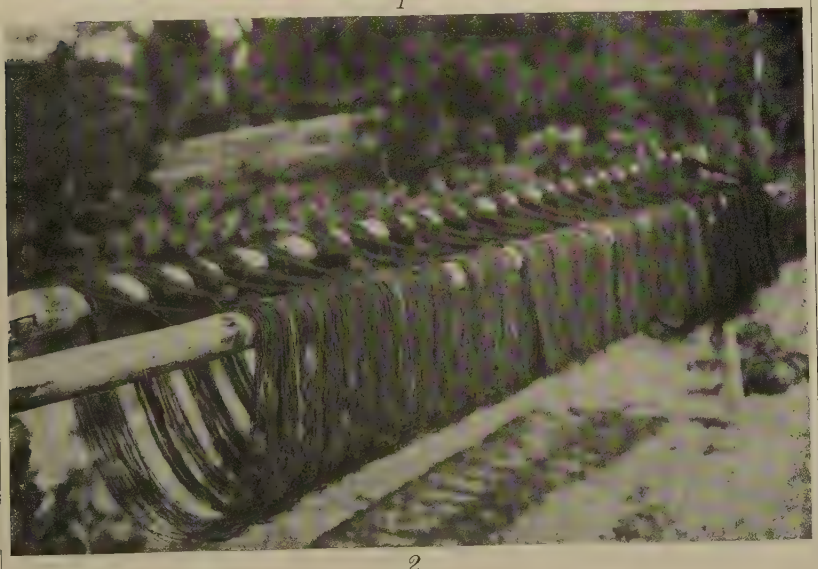

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PLATE 7.

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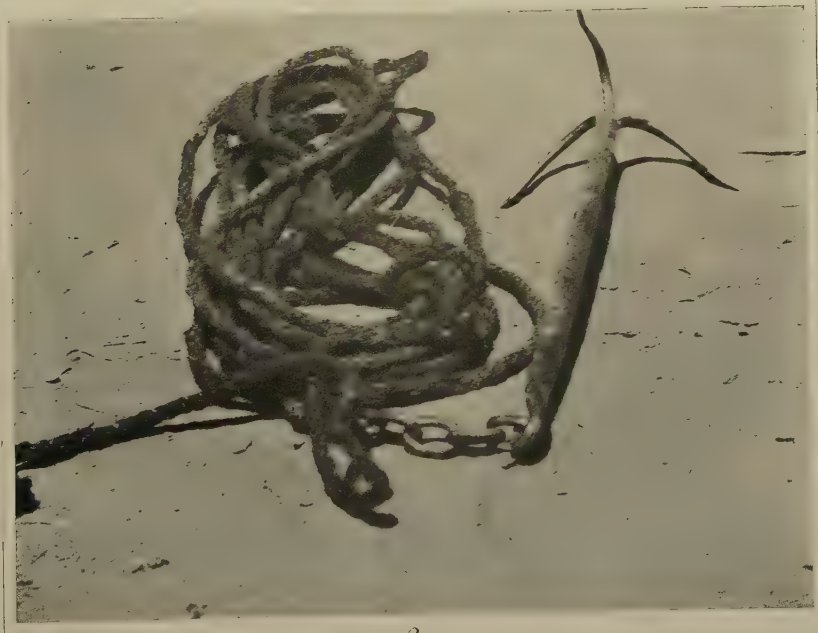

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PLATE 8.

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PLATE 9.

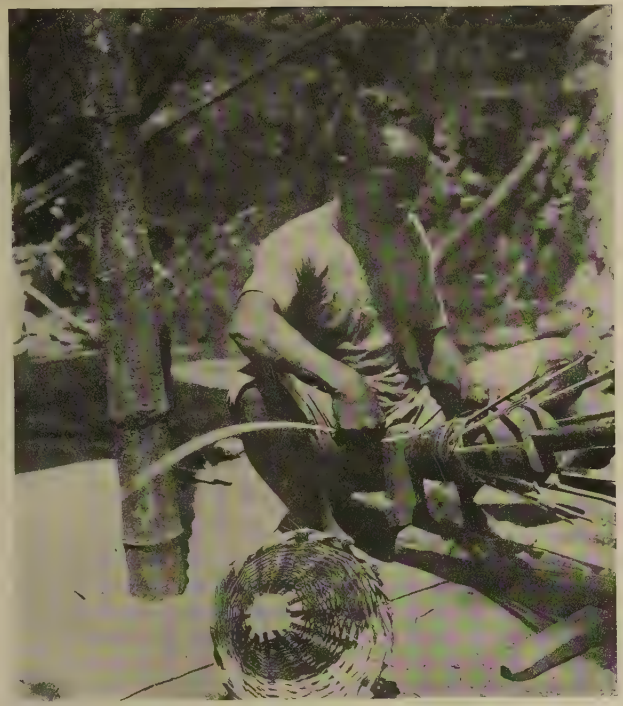

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PLATE 10.

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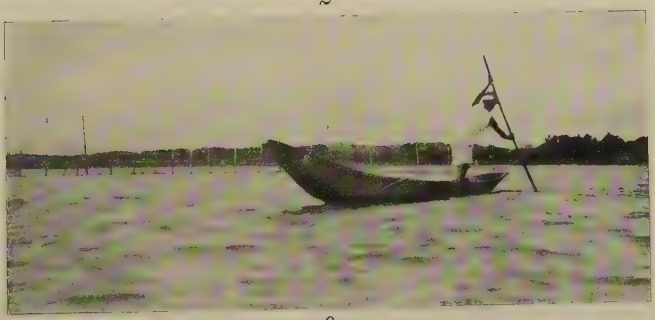

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PLATE 11.

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PLATE 12.

THE KANDULI FISHERY OF LAGUNA DE BAY

By VICENTE C. ALDABA

Of the Bureau of Science, Manila

INTRODUCTION

If quantity alone is considered, *kanduli* (family Ariidæ) is the most important fish in Laguna de Bay. It is not as valuable as *dalag* since it is considered an inferior fish, but because of its abundance and availability at all times the people living on the border of the lake make it their mainstay in animal food.

It is interesting to note that kanduli finds in Laguna de Bay the most suitable conditions for breeding and growth and multiplication. In no other fresh-water lake in the Philippines does kanduli even approach its abundance in Laguna de Bay. Just what the ecological conditions are in the lake that so favor the maintenance of a large kanduli population are practically unknown. In this connection it would be worth while to describe Laguna de Bay briefly, since by so doing an insight may be obtained into the adaptability of the lake for kanduli.

DESCRIPTION OF LAGUNA DE BAY

Laguna de Bay lies southeast of Manila Bay and is separated from the latter by a strip of land, roughly ten kilometers wide. It is over 2 meters above sea level. It covers an area of 930.7 square kilometers, excluding Talim Island, and is the largest fresh-water lake in the Philippines. It is irregular in outline, the northern part being divided into three lobelike sections by Jalajala Peninsula and Binangonan Peninsula with its southern continuation in Talim Island. Numerous small streams empty into it, but it is drained by only one river, the Pasig. The water level rises rapidly in the rainy season and subsides rather slowly. The bottom has naturally become muddy. The floor is practically level, the depression from the coast being gradual from all sides. With the exception of Diablo Pass, which is simply a short, narrow, deep strait between Talim Island and Binangonan Peninsula, the deepest portions in various sections of the lake during the height of the dry season vary from

about 4 meters (13 feet) in the western part to about 5 meters (16 feet) in the southern.

GENERAL DISTRIBUTION OF KANDULI IN THE LAKE

Kanduli dominate the deeper regions of the lake. At a depth of about 2 or 3 meters, the smaller kanduli are caught in *sakag*, corrals and other fishing apparatus. The larger individuals live in the deepest portions of the lake.

The explanation of this distribution of small and large kanduli may be found in the fact that young fish are largely herbivorous, and the old are mainly carnivorous and even cannibalistic. This may be easily demonstrated by opening the alimentary system of kanduli and is a fact well known among the fishermen. Figures obtained by Mane[1] confirm this assertion. Naturally, young kanduli are attracted towards the shore to feed. Here they also obtain their animal food requirements in the form of shrimps and other small crustaceans. The bill of fare of the old kanduli consists principally of smaller fish which are obtainable in deep water. The larger fish have a tendency to stay at the bottom where they probably obtain the snails that are usually found in their stomachs.

SPECIES OF KANDULI IN LAGUNA DE BAY

Five species of kanduli have been reported in Laguna de Bay; namely, *Arius goniaspis* Bleeker, *A. dispar* Herre, *A. thalassinus* (Ruppell), *A. manillensis* Cuvier and Valenciennes, and *Hemipimelodus manillensis* (Cuvier and Valenciennes). Certainly, the kanduli found daily in the markets are mainly *A. manillensis*. Since all the species are quite similar in outer appearance, it is not easy to differentiate the various species that may be found in a pile.

BREEDING HABITS

The breeding habits of kanduli are very little understood. The fact that they stay in the deeper regions of the lake renders it hard to make direct observations. When it is considered that there are a number of species, which are not readily distinguished one from another, it is not surprising that so little is known about the habits and life history of these species.

Spawning.—Fishermen are very well acquainted with the fact that spawning goes on during the height of the dry season; that is, from February to May. The greatest activity takes

[1] Philip. Agriculturist No. 2 18 (July, 1929).

place during March and April. The characteristics of spawning kanduli and of males carrying eggs in their mouths, which are of great importance to the fishermen, especially to the *pukot* operator, are that they appear to be in schools or at least are together and that they do not move around much. Therefore, when a good catch is made in one spot, it is very likely that similar luck would attend the fisherman's efforts next day in places adjacent to the first one. The other fishermen are quick to learn the news and soon a number of them are flocking around the place where the first catch was made. Thus the most critical moment in the life of kanduli, or when they are most likely to be caught, is during the spawning season.

Kanduli spawn in the deepest parts of all the more or less well-defined sections of Laguna de Bay, but they are also caught with mature eggs in places as shallow as 3 meters.

Incubation.—That the eggs are kept in the mouth of the male during incubation is readily observed, and is generally known among fishermen. Kanduli with eggs in their mouths may be observed even in the market during spawning months. The writer has been informed that at times when pukots are making large catches the eggs collected may aggregate a ton. In any event there are people who are making good money by diving for and selling the eggs which have been dropped on the muddy bottom by the kanduli during the confusion which takes place when they try to escape from the pukot bag. While information concerning the quantity of eggs collected during a lucky haul may be exaggerated, still it shows in a very realistic manner the destructiveness of catching kanduli during the spawning season. Certainly with these habits of kanduli which allow them to be so easily caught in quantities while spawning and incubating, the heavy depletion of the kanduli fishery is bound to result sooner or later as an outcome of the rapidly growing human population around the lake, unless fishing is properly regulated.

There is a redeeming circumstance, which prevents the total depletion of the kanduli fishery, and it is not unlikely that it is due to this that the kanduli population of Laguna de Bay has not as yet been very seriously reduced in quantity, in spite of the heavy fishing during the spawning season. This saving factor is the existence of a large number of corrals in deep sections of the lake. In many places a corral, once put in the water, stays there until it has become so weak as to be readily torn to pieces by the action of the waves. Then the owner sets

up another, not in the same place but usually near it. In the place of the old corral are the stumps of the old stakes, which make it impossible to operate a pukot without the danger of tearing the net. It is known that kanduli with eggs are fond of staying among these stumps and other remains of old corrals. Pukot operators know these places and avoid them.

By way of explanation it should be added that the period of incubation, as the phrase is used here, includes what properly belongs to brooding, since young kanduli are set free only when they are actively swimming and the yolk is used up. It is calculated that this brooding period may cover about two months.

GROWTH OF KANDULI

It has not yet been possible for the writer to make direct observations on the rate of growth of kanduli in Laguna de Bay and the data given in published literature which have been determined by indirect methods do not appear to justify their being included here to become a basis for practical recommendations.

MARKETING

Before taking up the methods of fishing and the measures for the protection of the fishery, the subject of marketing may first be discussed, since the preference of the consumer has a good deal to do with the size that the fishermen should catch. Kanduli eggs, young and small fish, as well as the old and large are all sold in the market so fishermen catch all sizes. The small kanduli which are not sold fresh are split and dried and put in the market as *daing*. When there are plenty of fish, even the large ones are dried and marketed in towns away from the lake. However, there are times when large quantities of very young fish are just dumped in places to rot because of lack of market.

METHODS OF FISHING AND FISHING GEARS

The methods of catching kanduli in Laguna de Bay have been discussed in a separate paper, "Fishing methods in Laguna de Bay." They will be discussed here only in so far as their importance to the fishermen and destructiveness to the fishery are concerned.

The *pante* (gill net) is certainly the most important fishing gear for kanduli, although the pukot is the most conspicuous on account of its size and the number of men necessary for its operation. Naturally, the occasional large catch of a pukot

makes this net a more interesting topic for conversation, but the pante, on account of the number of individuals employing it, the amount of capital invested, and the quantity of fish caught, certainly ranks first.

The pukot is nonselective and catches fish of all sizes that may happen to be inclosed in the net, but the main concern with this fishing gear in connection with the protection of kanduli lies in the fact that it catches kanduli with eggs in large quantities. (In the phrase "kanduli with eggs" is included not only the female with maturing eggs but also the male carrying eggs in the mouth.) Indeed, in operating the pukot the fisherman counts on the fact that during spawning and incubation kanduli come together in the deep places and move very little. Very small kanduli are also caught in the pukot at times.

The pante does not catch small kanduli. In order that kanduli may be caught in this apparatus, they must be moving in the water. Since kanduli with eggs stay quiet at the bottom they are not likely to be caught in quantities. The water is, therefore, beaten hard to scare the fish. They are then caught in the net.

The other fishing gears of importance are corrals, *kitang*, sakag, and *dala*.

The corrals do not catch kanduli with eggs to any large extent. It is in the fact that corrals may catch large quantities of small kanduli that they are included in this consideration of the protection of the kanduli fishery.

There are, for practical purposes, two kinds of corrals to be considered. The one for *ayoñgin*, sometimes known as *siid*, is planted near the shore, that is, in shallow places, and while it catches mainly ayoñgin, *Therapon argenteus* (Cuvier and Valenciennes), it also catches half-beaks (Hemirhamphidæ). When the water in the lake is turbid, which occurs particularly in the rainy season, large quantities of very young kanduli may come into the corrals. When the market happens to be scantily supplied with fish, these fingerlings may be sold, otherwise they are just dumped somewhere to rot.

The deep-water corrals, which are more numerous than the former kind catch *biang puti, Glossogobius giurus* (Buchanan Hamilton) and kanduli mainly. In the southwestern part of the lake the deep-water corrals are set only during the southwest monsoon, which coincides pratically with the rainy period,

and then are taken ashore for the next season. In the other parts of the lake the corrals are permanent; that is, once set in the water they are allowed to stay there as long as the parts hold together. As in the shallow-water corral, young kanduli in large quantities may come in at times.

The kitang, which is a trawl line carrying several thousand hooks at times, although a very important fishing apparatus, is not involved in the solution of the problems concerning the protection of kanduli. It catches only kanduli of good size that are already sexually mature, and catches practically no kanduli with eggs, since these evidently do not feed during the period when the eggs are held in the mouth.

The sakag both near the shore or in deep water is primarily for catching ayoñgin, but many times large quantities of very young kanduli are also caught.

The dala, or casting net, catches kanduli of all sizes besides other fishes, and may also take kanduli with eggs.

The other fishing methods of minor importance need not be discussed since they do not catch either the young kanduli or those with eggs. But the *tilay* should receive special attention in this connection since while it catches only large kanduli, it uses very young kanduli for bait. As the baits so used cannot be of any considerable number, that is, speaking in relation to the kanduli fishery as a whole, the use of undersized kanduli for bait for this particular fishing should be allowed.

DISCUSSION OF REGULATING MEASURES FOR PROTECTION OF THE FISHERY

In discussing the measures to be adopted for the protection of the kanduli fishery, there are several considerations which should be borne in mind. The fishery would certainly be depleted in due time with the increase in fishing activities around Laguna de Bay if they were allowed to go on unrestricted; but in adopting protective measures, these should not be to the extent of paralyzing fishing, unless it is shown that kanduli has been depleted to an extent that justifies extreme measures. Laguna de Bay naturally can support only a certain number of kanduli and protective measures that would permit the fish full liberty to breed at all times to the prejudice of fishing activities would be nothing but deliberate waste, since fostering such a number that cannot be naturally accommodated in the lake

would simply result in high mortality at the young stage. It would be wiser to catch the old fish and give more room for the young ones. Finally, the measure adopted must be effective. Certainly it would be difficult to find a happy medium among these considerations, but it is the only justified course.

The first remedy which readily suggests itself is the regulation of the size of the mesh of the nets and the distance between the slats of the corrals. This is not likely to be so effective. At present the interval between the slats of the corrals and the size of the mesh of the pukot, except the bag, are larger than the smallest kanduli which are caught. The small fish are caught apparently because they do not have the tendency of the other fish to go through spaces where they can, but simply continue moving around until they are unnecessarily disturbed when they force their way to escape. It is evident, therefore, that the problem does not consist so much in increasing the size of the mesh of the nets and the distance between the slats of the corrals since the young kanduli are likely to stay inside these gears in any event, but in giving the young fish a chance to escape immediately after they are caught. A delay in putting the young fish back into the water may kill them.

To allow the young fish to escape, the mesh of the bag of the pukot might be widened to the extent which would allow fish of certain size to go through. In the case of the corrals, the owner may have a small bag net, with the right-sized mesh, placed in the water but with the mouth high above the surface. Into this bag he can dump his catch as he is taking it out of the corral. Then, when he is through he can lift the bag out of the water into his banca ready for home or market.

The other fishing gear concerned is the sakag. The main catch of this is ayoñgin, which is a surface fish, and since kanduli stays mainly below the surface, operators of this gear have learned to separate the former from the latter while lifting it above the water. The question, therefore, of allowing the young kanduli to escape does not present any special problem, since by taking the ayoñgin first he can throw away the young kanduli or the process may be reversed as desired by the operator.

The next question involved is the size of the mesh of the pukot bag and the suggested corral owner's bag. In order to decide this point measurements of the length and greatest circumference of the body of a series of different sizes of kanduli were made.

The data are given in the following table.

TABLE 1.—*Showing the greatest circumference of the body of kanduli of different sizes. Measurement from tip of snout to tip of tail fin.*

No.	Length.	Greatest circumference around the body.	Remarks.
	mm.	*mm.*	
1	57	29.5	Measurement is around the shoulder girdle, passing through its widest expansion at the base of the pectoral fins. The part of the kanduli around which the measurement is made is inflexible.
2	91	44.0	
3	105	50.0	
4	127	62.0	
5	138	71.5	
6	157	74.0	
7	193	96.0	
8	208	113.5	
9	265	128.5	
10	308	160.0	

Published data show a minimum length of 135 millimeters measured from the snout to the end of the caudal vertebræ, for kanduli with maturing eggs. This size would be about equal to that of No. 6 in the table. Taking this as the maximum size of the fish which should be allowed to escape, the mesh of the pukot bag and corral owner's bag should be a little over 37 millimeters stretched. A mesh of 40 millimeters stretched should give a very good chance for kanduli of the size mentioned and even a little bigger, say 160 millimeters, to get away.

The next regulation measure is the prohibition of fishing during the spawning season. This would certainly be the most effective protection, so much so as practically to keep the kanduli unmolested in Laguna de Bay all the time. As has already been stated, the spawning season lasts from February to May and the brooding period lasts about two months, so that if the lake is going to be closed to fishing, the closed season must be from February to July. The important fishing gears which would be affected are the pukot, pante, corrals, kitang, and dala. As a general rule pukot and pante are not in operation during the rainy season, that is from June to November or December, because the nets cannot be dried during the rainy season and because of the heavy wind which is prevalent during these months. In other words, if kanduli fishing were prohibited from February to July on account of the rain and the wind, and the important net gears were inoperative from June

to November or December, the actual fishing season would only be in January or possibly as early as December. This would be equivalent to entirely prohibiting the fishing of kanduli by these methods, since people are not likely to make investments in nets if they can use them for only one or two months during the year. It is, however, true that there are pukot and pante, especially the latter, which are operated even during rainy days, and there are days in August, November, and December when fishing with pante is easily carried on, it being sufficiently sunny for the smaller nets to be dried.

The case of fish corrals has already been discussed and since this gear catches very few kanduli with eggs it may be exempted from the closed season provided the precaution already discussed is observed. Since the kitang catches neither small kanduli nor kanduli eggs, it can be exempted from all regulations.

The next measure to be considered is the closing of a part of the lake to fishing during the breeding season. The kanduli are known to breed in the deeps of the lake. There are several of these deeps, one in each lobe and one in the southern section. It would seem that by closing each section in rotation, the object of maintaining the supply would be accomplished since a large number would be allowed to breed uninterruptedly. There are two serious objections to this, however. It would be rather difficult to enforce and it would be hard and unjust to those who happen to live in the section of the lake where fishing is banned.

The second objection is readily evident. Since practically all the fishermen in the lake are engaged in fishing for kanduli in one way or another, the fishermen in a section that happened to be closed would be in a difficult position. They might try to go to other sections, but this is not readily accomplished for it takes a great deal of time to reach other sections in a banca rowed by one man and, when the wind is blowing hard, this is decidedly risky.

That some fishermen would be forced to go to other sections may be expected, and this would take into consideration the question of enforcement. Will fishermen caught sailing or rowing with their fishing gears in a closed section of the lake be arrested? If so, this would be equivalent to prohibiting these people from fishing in the open sections, since they have no other way of reaching the place where fishing is allowed. If they were allowed to row over the banned area on the pretext of being on their way to another section that is open to

fishing, why cannot a fisherman with his gear ready just drop it in the water as soon as he is out of sight. Since it would be a practical impossibility to follow every fisherman who might be found in a closed section, the real object of the regulation would not be attained at all.

The drawing of an imaginary line to separate a closed section from an open one would doubtless be a constant source of dispute. How can a fisherman tell whether he is on the right or wrong side of this imaginary line? How can an officer of the law prove that a man is fishing within the prohibited ground when he is near or just at this imaginary line?

The fourth measure to be considered is the closing of the fishing activity during part of the spawning season. Probably the best part of the spawning season in which to prohibit fishing is May. All eggs laid during this season can have an undisturbed brooding period in the mouths of the males by extending the closed season through June and July.

The regulation should cover all gears in which spawning kanduli and kanduli with eggs in the mouth are among the principal fish caught. At present this would include the pukot, pante, and dala. Since in May, June, and July, practically all kinds of fishing methods are doing well, and since in these months rice planting is going on actively in many parts around the lake no fishermen would find it hard to earn his living in spite of the closed season for catching kanduli. The pukot will have to lay off anyhow in June and July on account of the rain which makes it hard to dry the nets and also on account of the wind. Pukot, therefore, is in reality forced to lay off only in May. Pukot owners should welcome the closed season in spite of the little sacrifice which they are required to make since it is for the maintenance of their own business. The fishermen attached to the pukot can easily turn to other kinds of fishing or to planting rice. What has been said may be said also of the pante. Dala, since there are not many people engaged in this kind of fishing, need not be dealt with to any extent. Suffice it to say that the dala fishermen can readily go to other kinds of activities in the lake or in rice fields.

To summarize, a law or order for the protection of the kanduli fishery should provide for the following points:

1. The catching, selling or buying, or in any way being in possession of kanduli of 160 millimeters length measured from the tip of the snout to the tip of the tail fin should be

prohibited. Fishermen using hooks (*tilay*), however, should be allowed to use very young kanduli for baits.

2. The mesh of the pukot bag should not be less than 40 millimeters stretched.

3. The corral fishermen should provide themselves with a bag of ample diameter and depth to hold the ordinary catch without crowding to an extent that would prevent the escape of young kanduli. The mesh of this bag should be no less than 40 millimeters stretched.

4. Fishing in the lake with an apparatus by the nature of which kanduli with eggs are among the principal ones caught should be prohibited from May 1 to August 1. This should include for the present the pukot, the pante, and the dala.

A question which may now be asked is whether the insurance of the breeding and brooding during May, June, and July, and the prevention of the catching of certain sizes would be enough to replenish the kanduli which have disappeared from the lake during the current fishing year and gradually to restore the quantity which may have been depleted during the past years. This is very hard to answer directly since very little is known about the habits and life history of kanduli, and the quantity caught yearly. The question may, however, be answered from general experience. The fact that it has not been possible for fishermen to state definitely whether there is such depletion at all shows that it cannot be very much. Now, allowing kanduli to breed and brood undisturbed for part of the time and preventing the catching of a certain size would certainly mean increasing by so much the replacement which went on before the regulation measures were put into effect.

As already stated, the finding of the happy medium between all the considerations given above would be hard, but the recommended regulation is, certainly, an approach toward that point. In order to determine more definitely whether the measure is adequate, the kanduli fishery should be studied biologically as well as statistically. In this way a continuous study of the subject will show whether or not the measure needs modification or even abandonment for a better one.

THE DALAG FISHERY OF LAGUNA DE BAY

By VICENTE C. ALDABA

Of the Division of Fisheries, Bureau of Science, Manila

TWO PLATES AND ONE TEXT FIGURE

INTRODUCTION

This investigation was undertaken in order to determine in what way the important dalag fishery of Laguna de Bay may best be regulated, to the end that the supply in the future may not be unduly diminished. The time available for actual observations was short. Naturally the information obtained is more or less fragmentary, but with careful consideration it has been found sufficient to serve as a basis for definite recommendations. Furthermore, the data gathered show many problems in the dalag fishery that may be investigated intensively for the benefit of the industry.

Information was gathered in two ways—by talking to fishermen of good standing, and by direct personal observations. Statements by fishermen in one locality were carefully checked against statements in other localities and wherever and whenever possible, by personal observation. Particular care has been taken to observe the breeding habits of dalag, and the methods of catching this fish have been closely studied. Practically the entire coast of Laguna de Bay was visited and a great deal of time was spent on the lake, with fishermen or in a separate boat, observing the operation of the fishing apparatus both during the day and at night.

DESCRIPTION OF LAGUNA DE BAY

Laguna de Bay [1] has an area of 930.7 square kilometers, excluding Talim Island. The outline is very irregular, the northern side being cut into three lobes by the mountainous Jalajala Peninsula and Binangonan Peninsula with its southern continuation in Talim Island. This irregularity in outline increases considerably the shoreline of the lake. The direct bearing of this fact on

[1] Philip. Journ. Sci. § A 11 (1916) 223–226.

the dalag population of the lake becomes evident when it is stated that this fish lives in shallow water near the coast. Numerous streams drain into the lake, which in turn drains through Pasig River into Manila Bay. There is a large area of muddy bottom extending along the eastern coast from Pila River to Santa Maria River. This section is the most valuable dalag fishing ground in the lake. During March and April the water is at its lowest, but rises rapidly when the season of heavy rains sets in, which is usually from June to August. Sometimes the water rises as much as 2 meters. Since the shore is low and the slope gradual around most of the perimeter, the area of the lake is increased very considerably during the rainy season, the addition consisting mainly of grass lands covered with water to a depth of from a few centimeters to 2 meters or more. This annual event has an important bearing on the breeding of dalag and on its food supply. In sections with muddy bottoms stationary vegetation such as *Vallisneria* and *Nelumbium* are present in water as deep as 2 meters or more, and in many shallower places a sedge, *Scirpus grossus* Linn. is dominant. The most-striking plant is the water hyacinth, *Eichornia crassipes* (Martius) Solms. It is met with all around the lake and being afloat it can be seen drifting across the lake, in patches of varying sizes, with every change in the direction of the wind. This is especially true during the rainy season, when it becomes a constant source of worry to the fisherman since it may carry away any fishing apparatus that he may happen to have set in the water at the time.

FISH CAUGHT IN LAGUNA DE BAY

Other kinds of fishes are caught in Laguna de Bay, but the closest rival of dalag in importance is the *kanduli*, a catfish of the family Ariidæ of which several species have been reported. Dalag, however, is considered the superior fish and hence is more expensive. The regions of the lake inhabited by these two kinds of fishes are quite distinct, the dalag confining itself to the shallower water near the coast and the kanduli to the deeper portions. Fishes of lesser importance include gobies, of which *biang puti, Glossogobius giurus* (Buchanan Hamilton) is the most valuable; *ayoñgin, Therapon argenteus* (Cuvier and Valenciennes); *talilong, Mugil* spp.; *palos Anguila* spp.; *buanbuan, Megalops cyprinoides* (Broussonet); *tagan, Pristis microdon* Latham; climbing perch, *Anabas testudineus* (Bloch); and *hito, Clarias batrachus* (Linnæus). The last two are included

with dalag in the popular term "mud fish," and are caught with dalag in some of the fishing apparatus. The large quantity of shrimps caught daily should also be mentioned here if for no other reason than that these crustaceans furnish a large portion of the dalag's daily food.

MARKETING OF DALAG

Dalag is marketed alive. Dead dalag is not much in favor and hardly sells. This is because when dalag is killed just before cooking it has a much finer flavor. Dalag, therefore, is kept in water until it is sold.

The largest dalag, varying in length from 50 to 55 centimeters, are considered standard market size in wholesale buying and selling and are known as *solo* (single).

Each fish of this size is counted as one; other smaller fish are counted as "two-equals-one," or "three-equals-two," etc. Fishermen and fish dealers do not look at the length solely in estimating the size, but also at the bulk of the body, and where the fish feed well the standard solo may, therefore, be shorter. This system has a very salutary effect upon the dalag fishery since it discourages the catching of the small fish.

DISTRIBUTION OF DALAG IN LAGUNA DE BAY

A very interesting phenomenon in connection with the distribution of dalag in Laguna de Bay is the fact that it is practically limited to the shallow water near the coast. This is strikingly demonstrated by observing the two fishing gears known as *pukot dalag* and *pukot laot* while they are in operation. The first, as its name implies, is for catching dalag and is cast in water about 2 meters deep. It also catches kanduli and other fishes. The other is designed to catch kanduli in the deeper regions of the lake and seldom catches any dalag. These two fishing gears are similar in general make-up but the former is the smaller.

There are three plausible explanations for the fact that dalag is limited to the shallow places near the coast. Plant growth must influence the distribution of dalag in at least two ways: First, shrimps are more plentiful among plant growth and since a good proportion of the dalag's food consists of shrimps, it is natural that it remains in this environment; second, the breeding habits of dalag, which will be dealt with in detail elsewhere, would also take it among these verdant surroundings. The third explanation, and possibly the most potent factor, is the

fact that it has to come to the surface to breathe, being unable evidently to maintain itself for any length of time with the oxygen dissolved in the water. Bubbles are released every time it comes up to breathe.

The frequency of coming to the surface is greater in the young dalag. The fry (*anak dalag*) that are already swimming freely come to the surface every few seconds. This accounts, at least partly, for the apparent and extraordinary activity of the fry, and for the many bubbles on the surface of the water which betray the presence of a swarm even at a distance (Plate 1, fig. 1).

Observations were made on two good-sized dalag in a well of water 2 meters deep to discover the frequency with which they came to the surface to breathe. The data are given in Table 1.

TABLE 1.—*Showing the breathing intervals of two dalag. Observations made August 16, 1929.*

Dalag 1; about 50 centimeters long (estimated).		Dalag 2; about 35 centimeters long (estimated).			
Time of breathing.	Interval.	Time of breathing.	Interval.	Time of breathing.	Interval.
a. m.	*Min.*	*a. m.*	*Min.*	*a. m.*	*Min.*
11.08:30		11.09:30		11.32:30	2½
11.12:30	4	11.13	3½	11.34:45	2¾
(a)		11.14:30	1½	11.35:30	¾
11.21		11.17	2½	11.37:20	1⅔
11.23:30	2½	11.20	3	11.39:20	2
11.28	4½	11.21:30	1½		
11.30	2	11.23:30	2		
11.32:30	2½	11.25:30	2		
11.37	4½	11.28	2½		
11.39:20	2½	11.30	2		
Average	$3\frac{4}{21}$				2½

[a] Not observed.

The table shows that the larger dalag came to the surface to breathe on an average of every $3\frac{4}{21}$ minutes, and the smaller one, every $2\frac{1}{6}$ minutes. The intervals were very irregular, but this was evidently due to their being under observation. Oftentimes a fish would come to the surface to breathe but before accomplishing its purpose would sink to the bottom manifestly because it was frightened. Hence, the longer intervals which, however, are followed by much shorter ones. The average may, therefore, be taken as the normal frequency of breathing for these fish under these conditions.

It thus appears that in the deeper regions if dalag stayed at the bottom, where its principal food in the form of shrimps is mainly available, it would necessarily spend a great deal more time coming to the surface for air, leaving very short periods for "browsing" on the bottom. It is, therefore, necessary for dalag to stay in the shallower places near the coast where both food and air are readily available.

The distribution of dalag around the lake is general. Indeed, dalag fishing is a very important industry all over the populated coastal regions. There are, however, certain places where dalag are caught in very large quantities. A common characteristic of these places is a muddy bottom. Such localities are usually met with on coasts near river mouths and in indentations where the water is not disturbed. The most extensive and most valuable of these dalag fishing grounds is found along the eastern coast of Laguna de Bay, extending from Pila River on the south to Santa Maria River on the north. The most conspicuous feature of these places is abundant plant growth, mainly in the forms of *Nelumbium, Vallisneria, Chara,* and *Scirpus,* which find here a fertile medium for their development. This vegetation continually adds to the organic matter already present by constant growth and decay. Microscopic organisms naturally flourish and larger animals feed on these. Shrimps of the families Palæmonidæ and Atyidæ are present in large quantities and naturally attract the carnivorus dalag. These grassy places also present material for the nests of spawning dalag. The young fry, also,whose food must consist mainly of minute organisms, find here a rich feeding place, and this fact, in addition to the protection which standing vegetation affords the young swarms, must serve as a further inducement for the parents to deposit their eggs in these weedy surroundings. Thus, the relative distribution of dalag around the coast is greatly affected by the presence of vegetation which, in turn, requires a muddy bottom at reasonable depth for development.

A difference is noticeable in the distribution of the small and the large dalag. As has already been stated fry are very active and are found generally in shallow grassy places. They are limited in their habitation to the first few centimeter zones of the water, probably, as has already been explained, on account of their breathing habit, which brings them to the surface every few seconds. As they grow older and separate from the school they stay more at the bottom but still prefer the shallow water.

The large dalag are more sluggish in habit and prefer the bottoms of deeper places.

In the rainy season when the water has reached its highest level, dalag are present in large quantities in shallow grassy places and in rice paddies. As the water recedes, the large dalag, at least most of them, go back to the deeper water, while many of the younger dalag remain in ponds of water and in paddies until the isolation of these small bodies of water is complete and they are no longer able to get away. Here they are caught by fishermen with *salacab* or even with their bare hands (Plate 1, fig. 2).

Many young dalag are caught in these isolated ponds and paddies, but since they are too small to market they are seldom sold but are privately consumed. Most people seen following a harrow or draining small ponds are not professional fishermen. The question of whether this fishing should be controlled or not can readily be answered in the negative. If the fish are not caught, a large number of them will die after the pools dry up, which happens in most cases.

BREEDING HABITS

Spawning season.—Dalag spawn throughout the year. Especially is this true in rivers and regions where vegetation is plentiful, even during the dry season when the water level of the lake is at its lowest. But there are places during the hot months where the water recedes to a point where no vegetation is present, and here dalag seldom lay eggs until the water rises again. In these places people recognize a spawning season for dalag; but even in those sections of the lake where dalag lay eggs the year round, there is a season when spawning is more active. This takes place during different months in different parts of the lake. On the southern side the spawning begins about May and is very active during June and July when the water level has risen considerably. When the water is receding, dalag again lay eggs, although not so actively as during the rainy season. On the western shores, when the present observations were made during the latter half of July (1929), dalag eggs were not yet common. Fishermen stated that spawning was late because vegetation, mainly in the form of water hyacinth (*Eichornia*), was carried away to the opposite coasts by the wind and the water had not yet risen enough to cover the grassy portions of the shore. In the grassy region of the eastern side of the lake active spawning is said to start much earlier, being at

its height about March, April, and May; that is, during the dry season. However, it is known that egg laying goes on at all times, especially in *pugad-pugad*, an artificial nest used for trapping dalag, which can be seen floating in that section of the lake by the thousands during the dry months.

Mating of dalag.—It is generally known that the male dalag is smaller than the female. Indeed, there is a Tagalog phrase "magasawang dalag," which refers to a human couple in which the husband is smaller than the wife. During the active spawning season, sexually mature dalag are caught in pairs in many fishing apparatus. Pugad-pugad owners welcome this time since it very often means two fish in the trap instead of one. However, fishermen who catch dalag by means of *bonbon* complain of this season because the catch is very often limited to two in each trap, whereas at other times there are many more. Dalag mates are jealous of their privacy and are known to drive away any intruder. Hence, even in a large bonbon, when it is occupied by a dalag pair of good size, no others are permitted to take shelter there. This claim was verified by actual observation.

TABLE 2.—*Showing the number and size of dalag caught in each bonbon. Observations made June 20. Measurements in centimeters from head to tip of tail fin.*

No. of bonbon.	Number of dalag in the bonbon.	Length of dalag.	Sex.
		cm.	
I	2	45	Male.
		48	Female.
II	2	43	Male.
		47	Female.
III	4	22	Unrecognizable.
		33	Do.
		34	Male.
		37	Female.
IV	2	31	Male.
		33	Female.
V	4	22	Unrecognizable.
		28	Do.
		33	Male.
		37	Female.

Bonbons I, II, and IV show plainly enough the correctness of the assertion. In bonbons III and V the fisherman, before closing the baclad which surrounds the bonbon, took his com-

panion to drive the fish from the surrounding region into the bonbons by beating the grass and the water. He believed that the small ones caught in III and V were not originally there but were driven into them.

Building the nest.—It is very well known that dalag construct a sort of nest. Usually a more or less grassy place is chosen with water ordinarily from 30 to 100 centimeters deep. The nesting dalag vigorously beats the grass with its tail clearing a space about 30 centimeters in diameter. The grass growing in the middle is bitten off and arranged around the sides.

Dalag is not readily inclined to lay eggs in water without any vegetation. In a well where the water was about 1.5 meters deep and where there was no vegetation available, it was observed that pieces of green banana leaves which had fallen into the well were bitten and otherwise torn to pieces and arranged rudely around a space where eggs were laid by an imprisoned dalag. The writer has been told, however, that cases have been known of imprisoned dalag laying eggs without any nest in a well where no material was available for its construction. Such cases, however, must be rare, and to encourage spawning grassy surroundings are necessary.

Eggs are not laid immediately after the nest is constructed. A newly constructed nest without eggs is an assurance to the fisherman that the female is soon coming to lay, and he, therefore, sets his trap for her. This fact opens the question of whether or not it is the male that constructs the nest, as is the case with many other fresh-water fishes. The general impression is that it is the female, but fishermen of long experience in catching nesting dalag state that it is the male. This agrees with published information that "oviposition is provided for in a rude receptacle which is prepared by the male."[2]

Laying of eggs.—The eggs of dalag float in the water. The general opinion is that during the act of extrusion the position of the dalag is with the abdomen up. Information from various fishermen who live in different places around the lake and who claim to have seen dalag actually laying eggs sustains the general belief. Some fishermen, however, assert that the laying dalag lies on its back at the bottom, while others claim it is on or near the surface, so that the spurting of the eggs is visi-

[2] Gill, Theodore, Parental care among fresh-water fishes, Ann. Report Smithsonian Inst. (1905) 403–531.

ble. It is probable that in the shallows the fish appears to be lying on the bottom, while in deeper water it seems nearer the surface.

Not all the eggs are laid at one time. This is easily proven by the fact that a dalag caught after laying eggs still has eggs in the body. The general opinion is that the dalag breeds twice a year.

Hatching of the eggs.—The eggs are hatched in two to four days, but not all at the same time, and a good proportion of them do not develop young at all. Those that fail to hatch have a whitish appearance. There is a general belief that when the parents are caught the eggs fail to hatch. There may be some truth to this assertion since the eggs are then deprived of the necessary protection from other fishes.

Number of young.—The number of young varies with the size of the mother. In the larval stage, the young move in a compact mass, which makes it possible to estimate approximately their number. In one large school, the occupied area, roughly measured, was 40 by 50 centimeters. It was estimated that the number of larvæ in a square centimeter would average no less than five. Therefore, the number of larvæ in this particular school was not less than 10,000. In a school of advanced fry an estimate of the number is not so easily made, since they are moving briskly and the formation is not compact. The larger the fry, the greater their tendency to separate from each other. Attempts were made to catch a number of schools of advanced fry with a salap, but in each case only part of the school was caught. In one large swarm of fry varying from about 45 to 65 centimeters in length about 2,000 were caught, and it was estimated that this number was about half of the total. The number in the whole may, therefore, be placed at 4,000. If it is considered that this number is the remnant of the large school of larvæ given above some idea may be had of the number which survives to the stage when the fry leave the parent.

Care of the young.—From the time the eggs are laid until the fry are big enough to take care of themselves, they are closely guarded by one of the parents, and apparently in some cases by both. That this is the case is readily observed. By closely watching the spot occupied by the eggs or a swarm of fry, the movement of the water and standing plant growth betrays the presence of a dalag under them, and in clear water

it can be seen following the school wherever it goes. Cases are said to be known of carabao jumping suddenly as a result of the bite inflicted by a parent dalag when this quadruped happened to step into its nest.

Whether it is the parent or the fry school looking for food which determines the direction of drifting is hard to tell. In the case of a parentless school, probably about a month old, it was observed many times that there was apparently no definite direction in its movement, but whenever it came to a place where food was plentiful, as may be judged from floating materials, the fry gathered around for some time to enjoy feeding. That a parent can lead a school of fry seems to be shown by the following incident: A school of about 10,000 week-old fry was inclosed in a corral of *sinamay* reënforced by being placed between two baclad with the necessary stakes. The inclosure was about 3 meters in diameter. The object was to study the rate of growth of the fry under as nearly natural conditions as possible. The fry were so small that they could slip through the mesh easily, but no finer sinamay was available. Under ordinary conditions the school stays in the same spot day after day, and this was verified by the behavior of this particular school, which the writer visited every day or two. From observation of other schools, this one would not be ready to leave the resting place for several days. By that time the fry would be too big to go through the mesh of the sinamay. Before the setting up of the inclosure, the parent dalag had been with the school. When the inclosure was made, however, the parent was left outside. The next morning the inclosure was in the same condition as the day before, but all the fry were gone!

The care given by the parent dalag to the eggs and fry is very well known to the fisherman. During the spawning season, therefore, he goes out to look for eggs or schools and then captures the guardian with his gear of various kinds. This is discussed more fully elsewhere.

While the dalag is ready to protect its young against intruders, under adverse circumstances it is apparently ready to eat its offspring, also. Fishermen are unanimous in their claim that the parent eats the fry, and say that they have actually seen parent dalag grabbing at the young with their mouths. While there is hardly any question of the veracity of a statement in which there is practically universal agreement, still it should be remembered that the parent dalag cannot voraciously and habitually eat its young since a large number of the fry grow to

maturity. Probably it sometimes happens that when the parent on guard cannot find food, it is forced to kill the pangs of hunger by eating a few of its progeny.

GROWTH OF THE YOUNG

As far as the writer is aware, in the Philippines the growth of dalag fry from the time they hatch until they leave the parent and separate from the school has not been determined. It is of special interest in connection with the object of this investigation that this particular phase of the growth of dalag be studied. Special effort was, therefore, taken to carry out this study as nearly as possible under natural conditions.

A number of schools were located and samples of fry taken at different times for measurement. It was not possible to study the growth of the fry from a single school since after a certain age the school leaves the original nest and keeps on the move constantly. There are also other factors that make it hard to follow a school, chief of which is the occasional flooding of the breeding places by rains. However, by comparing the growth of fry of different sizes from different schools it was possible to obtain a very good idea of the rate of growth of fry to the time they leave the parent. Table 3 gives the result of this study.

TABLE 3.—*Comparison of rates of growth of dalag fry before leaving the parent.*

Swarm No.	Date samples were taken.	Length.	Number averaged.	Growth by difference.	Remarks.
		mm.			
II	July 19	4.7	10	----------	
	July 22	6.5	10	1.8	
	July 24	8.1	10	1.6	Carried away by water before next sampling.
VI	July 17	----------	----------	----------	Eggs laid.
	July 20	----------	----------	----------	Eggs hatched.
	July 22	5.1	10	----------	
	July 24	6.4	10	1.3	Carried away by water before next sampling.
VIII	Aug. 10	25.9	10	----------	
	Aug. 20	34.0	3	8.1	Carried away by flood before next sampling.
IX	Aug. 9	7.2	10	----------	Found in well
	Aug. 16	7.9	10	.7	
	Aug. 24	8.9	10	1.0	
	Sept. 23	50.1	4	41.2	
	Oct. 21	80.2	2	30.1	

In other schools it was possible to obtain only one sampling and, therefore, they were not included in the table.

As seen in the table the most nearly complete and longest record is that of No. IX which covered from August 9 to October 21. When this particular school was discovered the fry already averaged 7.2 millimeters in length. Judging from No. VI it is calculated that the fry were about 8 or 9 days old when the first sample was taken. The age of the fry which averaged 50.1 millimeters long on September 23 may, therefore, be placed at 54 days.

Dalag fry measuring from 50 to 65 millimeters still swim in schools. Small isolated dalag which the writer has caught or seen caught in various places measured about 70 millimeters in length. It may be considered, therefore, that fry leave the parent at about 2.5 months of age.

When over 20 millimeters long they are occasionally used for food, and when still larger they are employed as bait for kanduli in kitang (trawl line) in Laguna de Bay. It is when the fry are still in schools that they are so easily caught in quantities and are, therefore, tempting to fishermen. They are easily located, as has already been said, on account of the bubbling of the water which may be seen at some distance. It appears, therefore, that the most critical stage in the life history of dalag, the stage when they should be protected, is when the young are still in schools.

Variation in growth.—In a large number of individuals hatched at practically the same time, there will naturally be much variation in size as a result of variation in the rate of growth. The writer has observed many schools and has for some time thought that the different sizes observed were naturally distributed around a certain mean. On October 21, while visiting the school which had been under observation since August 9, it was noticed that the school had been divided strikingly into two distinct groups with respect to size, one group consisting of much smaller individuals than the other. The two that were caught, taken from each group, measured 61.5 and 99.0 millimeters long, an average of 80.2 millimeters (Table 3). The longitudinal dimension, however, does not show the difference so much as the comparative bulks would.

In this fact must lie the main explanation of the phenomenon observed in a dalag couple namely, that the female is larger

than the male. It is assumed that in dalag the female is naturally larger than the male, and that the difference is the result of the difference in the rate of growth. If this is so, then the individuals in a school should show a tendency to be naturally distributed around two means. In other words, there should be two peaks in the curve. The more advanced the growth of the fry, the more pronounced this tendency should be.

To test this proposition statistically, as large a number of the largest fry available in a school were caught and the length of each individual measured. The results are presented in Table 4 and in fig. 1.

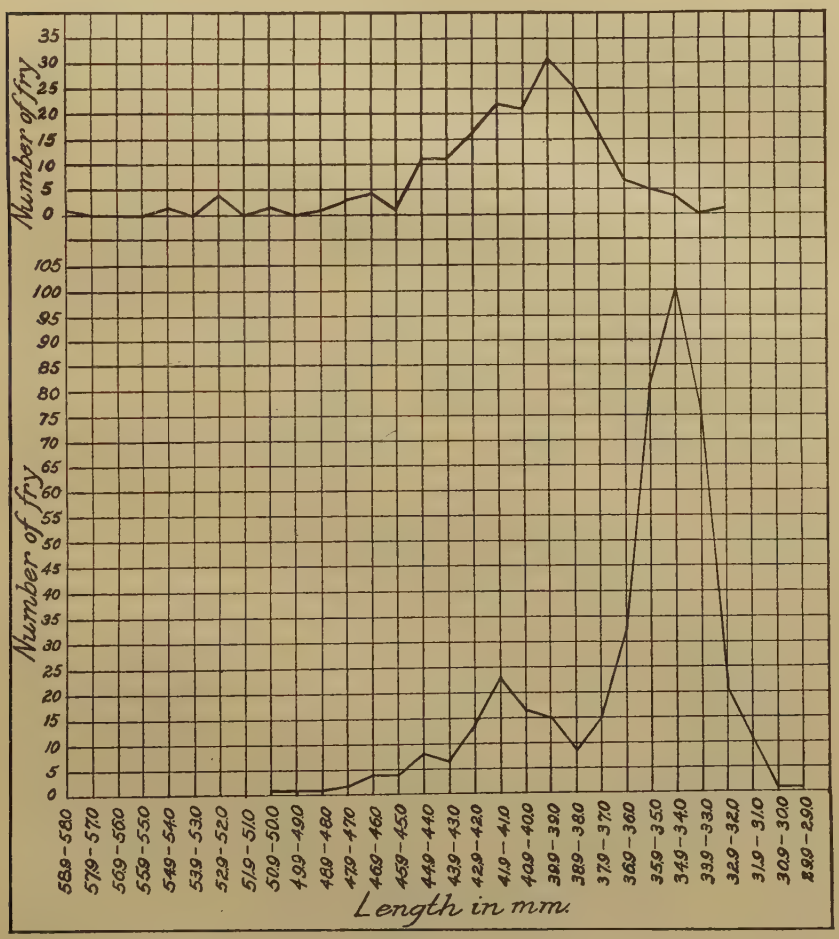


Fig. 1. Upper graph from data in Table 4; lower graph from data in Table 5.

TABLE 4.—*Showing the distribution of the large fry with regard to size.*

Length.	Number.	Length.	Number.	Length.	Number.
mm.		*mm.*		*mm.*	
58.9–58.0	1	49.9–49.0	0	40.9–40.0	22
57.9–57.0	0	48.9–48.0	1	39.9–38.0	33
56.9–56.0	0	47.9–47.0	3	38.9–38.0	31
55.9–55.0	0	46.9–46.0	4	37.9–37.0	17
54.9–54.0	2	45.9–45.0	2	36.9–36.0	7
53.9–53.0	0	44.9–44.0	11	35.9–35.0	6
52.9–52.0	4	43.9–43.0	11	34.9–34.0	3
51.9–51.0	0	42.9–42.0	17	33.9–33.0	0
50.9–50.0	1	41.9–41.0	22	32.9–32.0	1

This particular school was already well scattered, the fry being large and very shy. It was found very hard to catch them with the *salap*. Small ones were caught mostly; the larger, being energetic, easily got away. The data here given cannot, therefore, be considered as representative of the whole school. However, the curve is strongly askew on the left side as is to be expected, and there are groups of the larger size which would be hard to interpret except as indicating the formation of another peak if more of the larger ones had been caught.

In order to obtain a more representative population a school of smaller fry, and hence not so shy, was located. It was estimated that about one-half of the fry were caught. Table 5 gives the result of the measurements which have been graphed in fig. 1.

TABLE 5.—*Showing the distribution of the small fry with regard to size.*

Length.	Number.	Length.	Number.	Length.	Number.
mm.		*mm.*		*mm.*	
50.9–50.0	1	43.9–43.0	7	36.9–36.0	33
49.9–49.0	1	42.9–42.0	14	35.9–35.0	81
48.9–48.0	1	41.9–41.0	23	34.9–34.0	101
47.9–47.0	2	40.9–40.0	17	33.9–33.0	25
46.9–46.0	4	39.9–39.0	15	32.9–32.0	22
45.9–45.0	4	38.9–38.0	8	31.9–31.0	11
44.9–44.0	8	37.9–37.0	15	30.9–30.0	1
				29.9–29.0	1

It can be seen that the population is about twice the size of the first batch of fry and the curve presents a smoother appearance. The two peaks of the curve are plainly shown and as is

to be expected the first curve on the left is slightly skewed to the right, and the second slightly to the left.

AGE AND SIZE WHEN SEXUALLY MATURE

Fishermen in the lake are not definite as to at what age dalag matures. The general impression is that in one year it begins to bear eggs. The smallest female dalag seen during this observation, that carried mature eggs was 280 millimeters in length. From the rate of growth of the fry it is hard to estimate whether this size can be attained in a year. It should be stated, however, in this connection that availability of food has considerable influence on the rate of growth of dalag, and also that from the fry size to the sexually mature size, just mentioned, nothing whatever is known about the curve of the rate of growth to enable one to make a close guess. Herre [3] states that dalag grown in his office became sexually mature in eighteen months when they may attain a length of 250 millimeters.

REGULATION MEASURES FOR THE PROTECTION OF THE DALAG FISHERY

There are several ways that readily suggest themselves by which the dalag fishery of Laguna de Bay may be protected. These are, (1) entirely prohibiting the catching of dalag during the spawning season, (2) prohibiting certain destructive fishing apparatus, or allowing their use only during a certain part of the year, and (3) prohibiting the catching of dalag of a certain size or at a certain period of its life history.

The prohibition of dalag fishing during the spawning season would seem at first thought to be the most effective. It has, however, been shown that in some parts of Laguna de Bay dalag spawn throughout the year. If a closed season for fishing is to be established, it must be for the part of the year during which spawning is most active. As has been mentioned before, there are two active spawning seasons that vary in different places and in reality overlap. When this fact is taken into consideration it will be seen that a law covering all the months when active spawning is going on somewhere in the lake, would prohibit fishing from March to November, leaving only three months open, but there is another important factor to be taken into account; namely, the period when the fry remain together in a

[3] Philip. Journ. Sci. 24 (1924) 690.

school. The importance of protecting dalag fry at this stage has already been discussed. This period covers about ten weeks. In order to protect the fry that are hatched in November, the closed season would have to be extended to February. In other words, fishing would be entirely stopped. Thus, the closed season idea would defeat its own object, which is to protect the fishery for the benefit of fishermen and consumers.

The next measure to be considered is the absolute or partial prohibition of the use of all destructive fishing apparatus. This leads first to a discussion of all the fishing apparatus for catching dalag.

The methods of capturing dalag in Laguna de Bay are discussed in a separate paper, "Fishing Methods in Laguna de Bay." Here, however, it will be sufficient to consider those methods only with respect to their bearing on the conservation of the dalag fishery. The most important in this connection is the catching of the fry by the salap. This apparatus consists either of a net of fine mesh or of a sinamay cloth rigidly mounted on a circular or triangular frame and handled by one or two persons, depending on the size. As has already been said, the school of fry is first located and then scooped with the salap. In one operation from several hundred to one or two thousand young fish may be caught, though the bulk is small and only enough to satisfy a few persons at one meal. These are already good-sized fry and, if given a chance, a very large number should be expected to reach marketable size, but the salap is a legitimate apparatus for catching shrimps and fishes of different kinds, especially dulong, *Mirogobius lacustris* Herre. It would not, therefore, be fair to prohibit entirely the use of salap.

There are apparatus which take advantage of the nesting habit of dalag in their operation. *Loóng* is constructed to attract prospective laying dalag. When a dalag has laid her eggs in this hole, for that is what loóng essentially is, the fisherman waits for the parent which he knows is close by, with his salacab, or hook (*patucba* or *galay*, especially the latter). Most fishermen do not make loóng but hunt for dalag nests during the active spawning season. In this case, in addition to the fishing contraptions already cited, the rattan *bocatot* is also employed. The question presents itself as to whether these fishing methods should be regulated or entirely prohibited by law. The loóng is designed especially to attract laying dalag, and the rattan bocatot is made to catch dalag in the nest. The others are used for catching fish which are not laying. Practically all these

apparatus catch the parent dalag in the nest only after the eggs have been laid and hatched. The objection, therefore, to these fishing apparatus lies mainly in that the eggs and fry are deprived of the protection of the parent. Just how much destruction this means to the fry is very hard to estimate. But the writer has seen a large number of nests, with eggs, and schools in a place being daily ransacked by fishermen, and many of the schools must have been deprived of the protection of the parents, and yet the schools thrived. It appears, therefore, that the use of these apparatus is not objectionable, especially when it is considered that other fishing gears which catch non-spawning but sexually mature dalag do not even give the fish a chance to lay eggs. There are also other traps which should be considered in this connection; namely, the pugad-pugad and *pangloob*. These also attract nesting dalag. However, the eggs laid in these traps receive better protection than if they had been laid outside, and, therefore, the traps are rather an advantage.

The third measure to be dealt with is the prohibition of the catching of dalag of certain sizes, or at certain periods in their life history. It has already been stated that the system of marketing dalag discourages the catching of the small fish, but this applies only to the small individuals which have left the parents and separated from the school to live a more or less independent life. It has been shown that the most critical stage in the life history of dalag and the stage when they most need protection is when the young fry are still living in a school. At this stage the fry are known all around the lake as anak dalag. Their protection cannot be overemphasized. The catching of anak dalag by whatever means should be absolutely prohibited. When the regulation is properly enforced the dalag fishery will be adequately protected, at least for the present.

ILLUSTRATIONS

PLATE 1

FIG. 1. Bubbles created by a school of dalag fry.
2. People fishing for dalag in a field that is being prepared for planting rice.

PLATE 2

Favorite spawning place for dalag. Nests are usually made in grassy indentations along the shore lines.

TEXT FIGURE

FIG. 1. Upper graph from data in Table 4, lower graph from data in Table 5.

1

2

PLATE 1.

PLATE 2.

THE IPON FISHERIES OF NORTHERN LUZON

By Jose Montilla

Of the Division of Fisheries, Bureau of Science, Manila

SIX PLATES AND SIX TEXT FIGURES

One of the most important industries of northern Luzon is the catching of *ipon*. Ipon is an Ilocano name for the fry of various species of gobies that spawn in the sea but spend most of their lives in the fresh-water streams of the interior. Gobies are small fishes, carnivorous bottom-dwellers living along the shores, lakes, rivers, and fresh-water swamps. Some cling to rocky places or gravelly bottoms where the current is very swift and where few other fishes are able to withstand the rush of the water. The adult gobies reach a length of from 8 to 25 centimeters and the young, when taken, are usually less than 3 centimeters in length (Plate 1, fig. 1).

From about June to August the adult gobies descend to the sea to spawn and during the period from September to March the ipon arrive near the coast of northern Luzon. They approach the shore in vast shoals with the incoming high tide about nine days after the first full moon of every month during the ipon season, and have been observed to linger for four or five days before they attempt to enter the streams. The ipon are then scaleless and whitish in color with tiny dark brown or blackish crossbars on the body; their eyes are black and prominent. Fishing begins along the coast in water from 1 to 10 meters deep as soon as swarms of ipon are sighted. The fish are caught during the day and during bright nights. At certain places in the river fishing usually lasts from three to four days of each month during the season, since the schools move upstream at different periods.

Ipon prefer to enter rivers having sandy or gravelly bottoms, clear water, and strong currents. When moving upstream they go in great schools, stopping among the rocks, stones, and sand to rest. It has been repeatedly observed that they travel in the daytime and during bright nights and stop to rest during dark

nights. The fish ascend very slowly, taking about twenty-four hours to cover the distance of 1 to 5 kilometers.

The ipon that enter the river in schools vary in size. The larger kinds usually stay at the bottom of the river and seldom come to the surface. The smaller ones are usually found on the surface and, being more active, often jump over the traps.

It is generally conceded by the Ilocanos that there is no finer table fish than the ipon caught in salt water. Their flavor is delicate, wholesome, and much preferred by the natives. As soon as the ipon enter the river they become darker in color and acquire a bitter taste and are, therefore, not considered a delicacy. Practically all ipon are converted into *bagoong;* small quantities are prepared for the table in various ways, the commonest being *tamales* and *sinigang.*

Bagoong is prepared by mixing two parts of ipon with one part of salt; sometimes the proportion is three parts of fish to one part of salt by bulk. Ilocano salt is usually used. The mixture is placed in earthenware jars, well covered to exclude flies and dirt. It is allowed to ferment for about a month or longer. If well made, bagoong is a clean, wholesome article of diet.

Tamales are prepared by wrapping fresh ipon with banana leaves, and then boiling in water containing vinegar and salt. Sinigang is simply fresh ipon cooked in water with the addition of tomatoes and salt.

The most important fishes constituting the supply of the industry are the following: Palileng, *Sicyopterus lacrymosus* Herre and *Ophiocara aporos* Bleeker, Plate 1, figs. 2 and 3; bal-la, *Glossogobius giurus* (Buchanan Hamilton) and *Glossogobius celebius* (Cuvier and Valenciennes), Plate 2, figs. 1 and 2; bucto and bunog, *Chonophorus melanocephalus* (Bleeker), Plate 2, fig. 3; virot, *Eleotris melanosoma* Bleeker, Plate 3, fig. 1; and campa, *Rhyacichthys aspro* (Kuhl and Van Hasselt), Plate 3, fig. 2.

FISHING METHODS USED

The principal appliances used in the commercial capture of ipon are nets and traps. The former are by far the more important, of which the seines and dip nets are the more widely used.

THE SEINE

The seine consists essentially of a long shallow strip of net with a buoyant headline and a weighted ground rope, and is

particularly adapted to shallow water on gradually shelving beaches.

A seine, varying in style and size, locally known as *daclis de ipon,* is used all along the shores of northern Luzon. It is made of sinamay cloth, 40 meters long, 3 meters wide at its widest portion, becoming narrower towards the end of each wing where it is about 2 meters wide, and is provided with a bag at the middle. The daclis is operated from the shore and used along the coast within 200 meters of the shore line. From fifty to one-hundred persons are required for its operation. It is also used in the mouth of the river where the water is about 3 to 10 meters in depth. During the ipon season a good haul will often bring in as many as 10 to 20 cavanes (1 cavan equals 75 liters) of fish, the usual haul being about 2 to 5 cavanes.

A new daclis of the size stated above, costing from 300 to 400 pesos, may belong to one person or several persons. The owners rent it to fishermen and the proceeds from the sale of the ipon caught are divided equally between the owners and the renters. One-third of the share of the owners goes to the persons who repair the net. One-third of the share received by the fishermen is given to those who pull the net to the shore. The annual license fee is based upon the size of the daclis. It is customary for the owners to deduct this fee from the sale of the first big catch of the season. In 1928 there were five daclis in use in Bangar.

The daclis used in the towns of Santa and Caoayan, Ilocos Sur Province, is similar to the one described above except the dimensions. It measures about 31 meters long, 4 meters deep along the middle, and 2 meters deep at the end of the wings. The bag is nearly 12 meters long. The net is of very fine mesh, too small for the fish to go through, there being eight meshes to the inch.

In 1928 there were no daclis used in the jurisdiction of the municipality of Aparri because a municipal ordinance exacted a tax of 200 pesos for each daclis per year. The exorbitant fee has discouraged the use of this important fishing apparatus which is claimed by the people of Aparri to be destructive to ipon fishing. As a matter of fact, although it is made of fine sinamay, it is not used all the time and its field of operation is limited because of the small size, being only about 40 meters in length.

The *garamgam* is a seine similar to the daclis, only smaller. From twenty-five to thirty persons are needed to operate it. It

is used both along the seashore and in the mouth of the river in the municipality of Bangar, La Union.

Both the daclis and the garamgam are tanned with the bark of trees, especially mangrove. If treated each year, the net will last from three to four seasons.

CAPUT

The *caput* is a kind of dip net, mounted on a triangular bamboo frame (Fig. 1). Each side of the net is about 2 meters long. The netting is made of fine sinamay which is about 3 meters long and forms a long bag at the center. One man operates the caput by pushing and lifting it from time to time. It is used on sandy sea shores and in rivers. Being a small net, it catches but small quantities of fish and is practically useless when the ipon are scarce. It is not employed for commercial purposes, and what ipon are caught with it are kept for domestic consumption. It is not a very effective gear, but is used all over the provinces of northern Luzon.

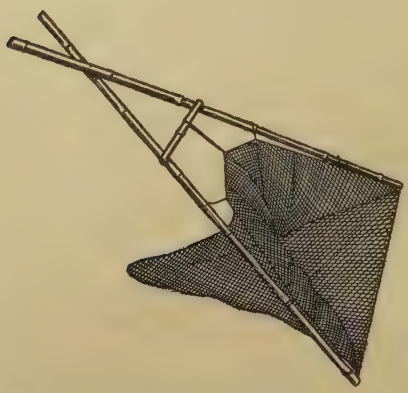


FIG. 1. Dip net, caput, used for catching ipon.

FISH TRAPS

In this region by far the greatest amount of marketed ipon is taken from the rivers in the more elaborate devices collectively known as traps. These are fixed structures which vary in construction and arrangement from the simple single-line dam across the stream to the more complex designs with series of barricades, blind canals, and pockets. The component parts consist of stone dams, bamboo fences, woven-bamboo matting (sawali), banana leaf-sheaths, dip nets, and bobos. There are no less than five types in use, which are all ingeniously devised with deadly purpose. They are built in the river beds during the dry season when the water is at its lowest. The most important of these traps are the *bobo, sarep, pingi, pamoboan* or *padait,* and *pamalibtocan* or *burayoc,* which are described and illustrated in the following paragraphs. It is well to point

out here that in all these styles the main idea is to lead the fish and snare them in the pockets which may be in the form of hoop-nets or bobos. Obviously the collecting receptacle is of the greatest importance in a trap.

Bobo.—The bobo (Fig. 2, and Plate 4, figs. 1 and 2) used with the above-mentioned devices is of a particular construction. It is made entirely of finely smoothed bamboo splints; in form it resembles closely a large bottle with a small short neck; it is 79 centimeters long and 26 centimeters in its greatest diameter, the opening at the end of the neck is about 7 centimeters in diameter. The catch is removed through this opening, which at other times is kept closed with a cork. At the other end is the mouth which is provided with a funnel with four openings, each 2.5 centimeters in diameter; behind this funnel is a secondary funnel 50.5 centimeters in total length, with a comparatively long tube 2.5 centimeters in diameter; this tube is in the same vertical line with the opening of the neck and its opened extremity is 9.5 centimeters from the cork.

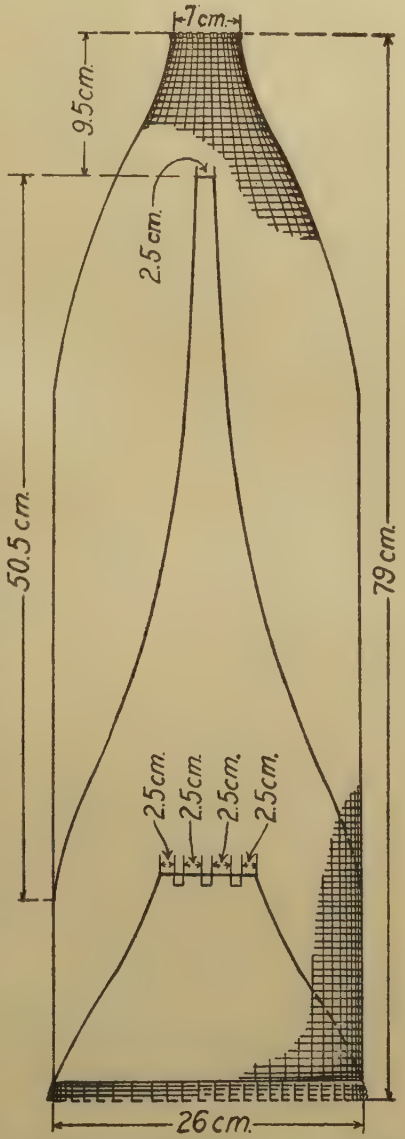


FIG. 2. Diagram of a bobo showing position of inside funnels.

Sarep.—The sarep is a row of bobos held in place at the bottom of a stream between bamboo piles driven about a foot apart. The mouth of the bobos is level with the ground and faces downstream purposely to catch the ipon swimming on the bottom against the current.

This gear is generally set across a third of the river, although it is not infrequently found extending across the entire width of the channel. It is very effective in shallow water, about 1.5 meters deep, with a swift flow. The sarep is used only in Abra River in the vicinity of Caoayan and Santa, Ilocos Sur.

In Cagayan Province the device known as bobo is exactly like the sarep in construction, except that it is set close to the river banks, since Cagayan River is deep and wide with very strong currents.

Pingi.—In Ilocos Norte Province the river traps used for catching ipon are known locally as pingi. The construction of the pingi varies according to locality. The pingi near the coast is set in places where the water is about 2 feet deep. It is built in the following manner: Bamboo piles a little over a foot apart are driven across the width of the river, except a space of 12 meters in the middle. Between the bamboo posts, holes are dug to accommodate the bobos, the mouth of which should be level with the ground. These bobos are 92 centimeters long and 31 centimeters in diameter. The mouth is provided with a funnel with seven small holes, each 2 centimeters in diameter. At the top of the bobos a wall of sawali is constructed. The upper edge of the wall is slightly below the surface of the water; it is inclined a little with the direction of the current in order to make a waterfall. This prevents the fish from jumping over. Sometimes a small piece of white cloth is placed at the top of the wall to frighten the ipon, thus preventing them from jumping over the fish trap. Herewith is shown a sketch (fig. 3) of a pingi at Laoag River about 1 kilometer from the shore, (Plate 5, figs. 1 and 2, and Plate 6, fig. 1 show the setting and operation of this apparatus).

The pingi described below (fig. 4) was constructed in 1928 at the back of the municipal building of Sarrat, an interior town of Ilocos Norte. This may be considered a variation of the pamalibtocan, since the fundamental idea involved is the same.

The part of the trap marked D is built with stones topped with a wall of banana leaf-sheaths. C represents a canal about 16 centimeters wide and approximately 16 to 18 centimeters deep. B represents the bobos placed at the extremities of the canal C and at the ends of the barricades marked D_1 and D_2. The bobos at D have their mouths downstream, and those at D_1 and D_2 face the current. D_5 represents a barricade built with stones and gravel along the bank of the river to make the surface stream narrower. D_6 and D_7 represent barricades built with

FIG. 3. Pingi near the mouth of Laoag River.

the same materials used for D_5, and high enough so that the water cannot overflow them. D_3 and D_4 represent dams built with big rocks and gravel. The top of the dam is from 3 to 5 centimeters below the water. The dams are so made as to increase the velocity of the current. This is an important factor since the ipon in going upstream prefer to swim against a strong flow. D_1 and D_2 are dams constructed in the same manner as those of D_3 and D_4, but their top is above the water. At one end of the barricades a bobo is placed.

Pamoboan or *padait.*—In the interior of Amburayan, Abra, and Laoag Rivers where the water is not deep, the fishing device used is the pamoboan (in La Union) or padait (in Abra) (Fig. 5).

In the sketch D represents dams which are built with stones upon which is erected a wall made of banana leaf-sheaths. These sheaths are piled just high enough to let the water pass over and form a waterfall. D_1 represents dams constructed with gravel and big stones or rocks. They are built high enough to prevent the water from overflowing them. This part of the trap is designed to increase the current going to the parts of the dam indicated by D. B represents bobos placed at the extremities of the canal, shown by C. The canal is about 16 centimeters wide and 16 to 18 centimeters deep. The water in this canal is quiet and the ipon follow it only to be entrapped. N represents hoop-nets (pataya) made of sinamay about 60 centimeters in diameter, with a bag about 2 meters long. The hoop-nets are placed at the side of the fences or barricades, shown by F, in order to catch the ipon that are trying to return downstream. The pamoboan is a very destructive method. Along Abra River there are several lines of pamoboan catching ipon that have escaped the preceding inclosures and leaving very few to go further upstream.

Pamalibtocan or *burayoc.*—The pamalibtocan is a device consisting of bamboo fence, coco palm leaves, banana leaf-sheaths and hoop-nets. It is found to be effective only in shallow places where the water is about a meter deep. A sketch of a pamalibtocan in operation about a kilometer from the mouth of Amburayan River is here shown (Fig. 6). F represents a fence called *bayabay* which is constructed of coco palm leaves and bamboo. It is made practically water-tight, sufficiently strong to direct the current to one side and usually high enough to prevent

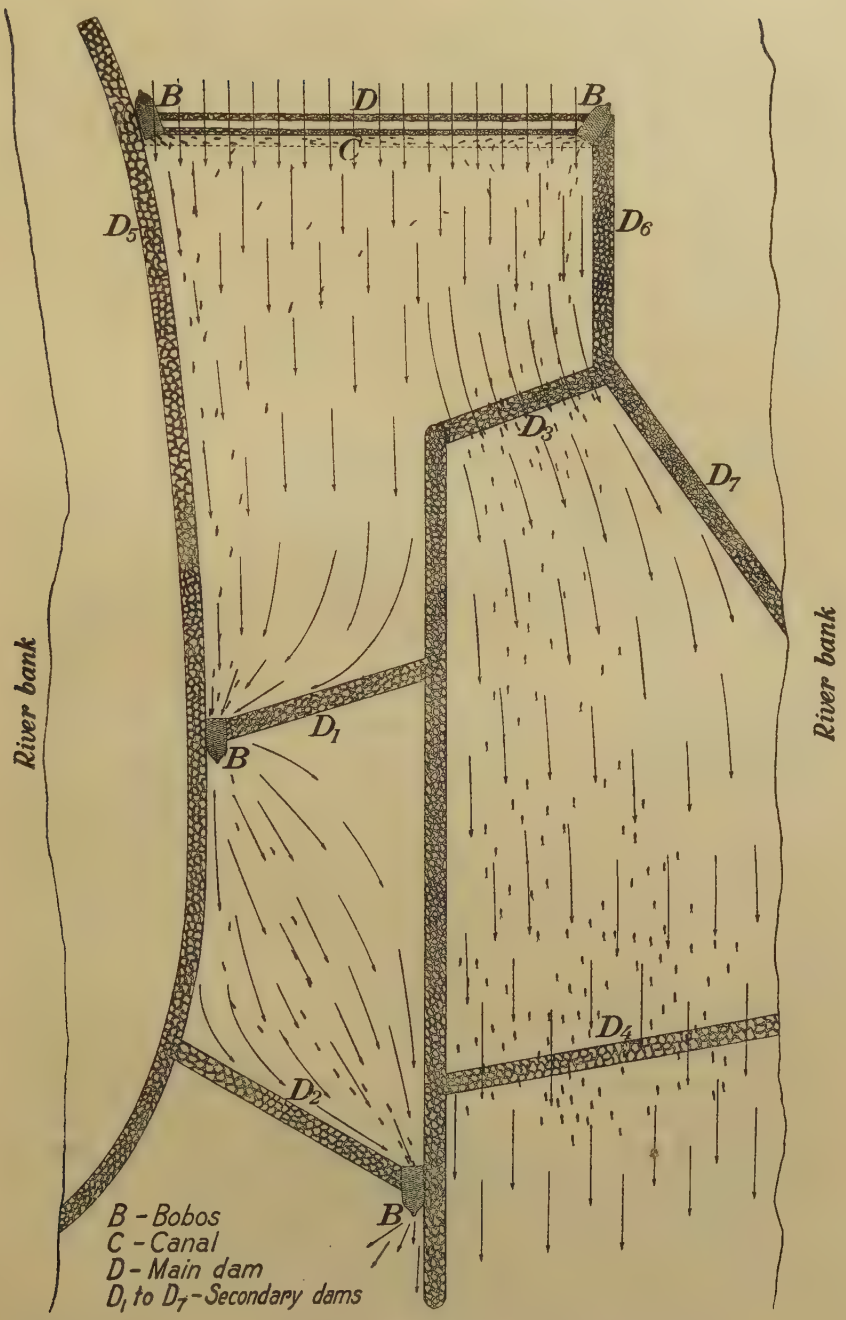


FIG. 4. Ipon trap, pingi, in the interior near Sarrat, Ilocos Norte.

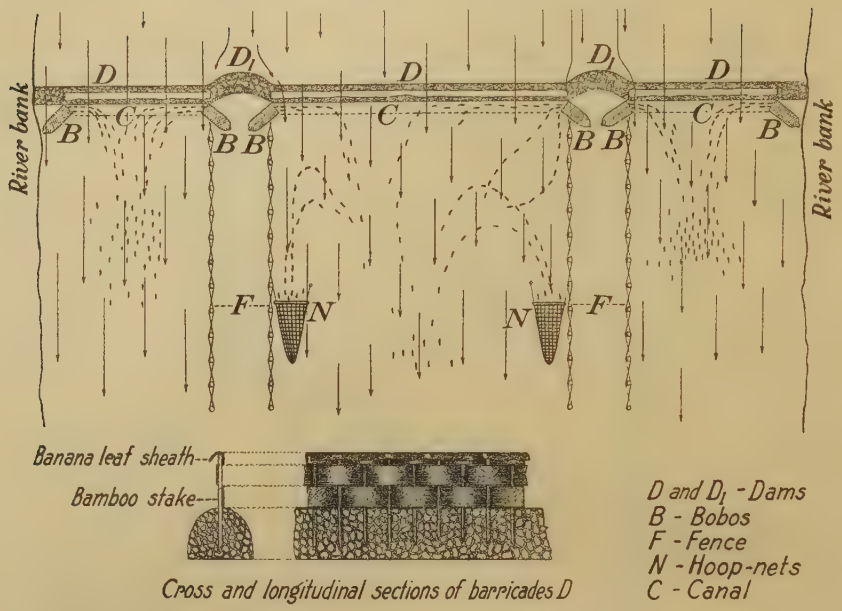


FIG. 5. Ipon trap, padait, near Bangued, Abra.

the water from overflowing it. It is from 8 to 10 meters long. D_1 represents a dam in the shape of an inverted V, made of stones, coco palm leaves and bamboo; the outer side upstream is reënforced with stones and earth; this side is about 3 to 4 meters long. The top of the fence is sufficiently exposed. The wedgelike obstructions increase the velocity of the flow of water over barricade D, indicated in the sketch. The strong current thus produced prevents the ipon from jumping over the banana-sheaths on top of the dam represented by D. In building a dam, the big stones are removed and the place is leveled and smoothed. Then bamboo piles are driven one foot apart. Good-sized stones and earth are piled to make the dike and upon this a wall of banana leaf-sheaths is erected. The last banana leaf-sheaths at the top are so placed as to produce a sort of waterfall with the current. Below the fall is a canal, represented by C. The water in this ditch is quiet, and it is by means of this blind alley that the small creatures are led into the traps. The curved banana leaf-sheaths by their movements and silvery appearance frighten the ipon, thereby preventing them from going over.

N shows hoop-nets placed at the ends of the canals where the ipon are led and trapped. B shows the bobos. These are set with the mouths on a level with the ground and facing the current and placed where the flow is very strong, for the ipon

usually go where the velocity of the water is greatest. F_1 shows a fence similarly constructed as F, made to guide the fish into the hoop-nets represented by N_1. These hoop-nets are cone-shaped and made of sinamay, the bag of which is about 2 meters long, with a mouth 70 to 80 centimeters in diameter. The hoop or ring is made of bamboo.

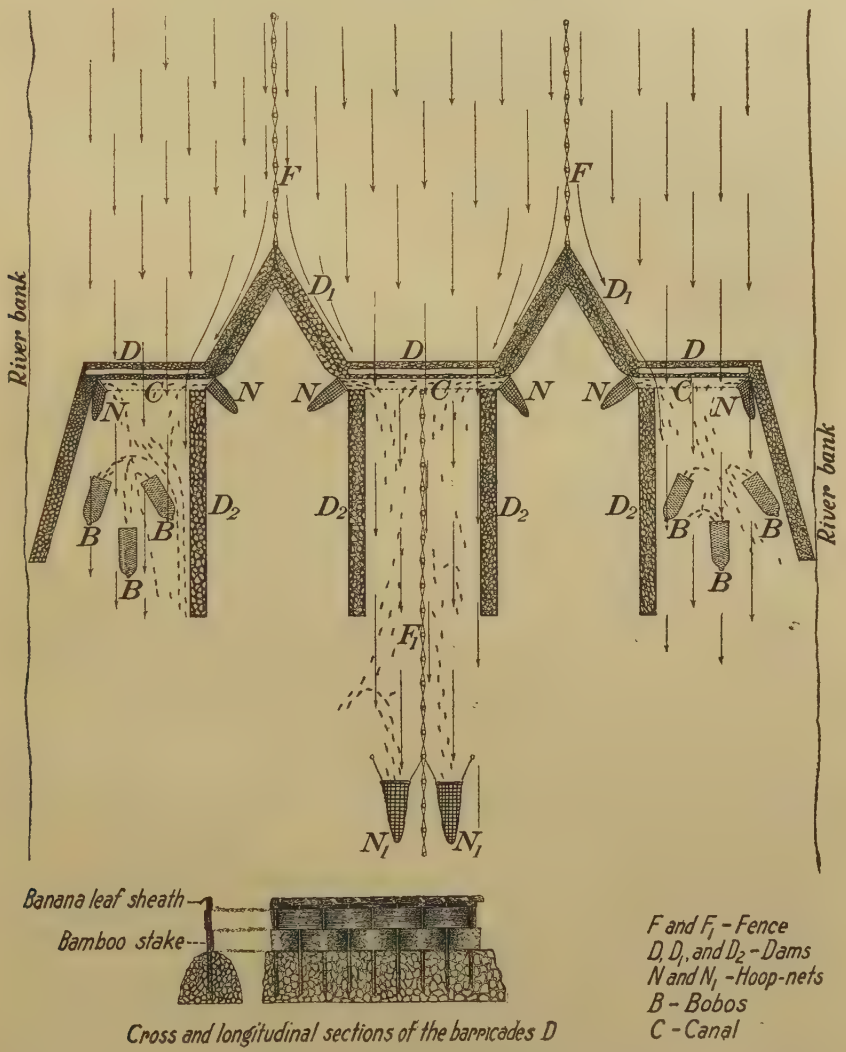


FIG. 6. Ipon trap, pamalibtocan, located about 1 kilometer from the mouth of Amburayan River.

The pamalibtocan is a very effective device. Oftentimes it is placed across the whole width of the river, and when so set,

it allows but a few fish to escape. In certain localities it is not unusual to see several series of this trap damming the stream, so that the chances of the ipon to escape and to reach the headwaters are very slight indeed. (Plate 6, fig. 2 shows the setting of pamalibtocan at the Amburayan River.)

THE ECONOMIC IMPORTANCE OF IPON

In La Union Province, ipon are fished along the coast and in four rivers. Two of these rivers, the Aringay and the Bauang, are very narrow, and their mouths are sometimes completely closed, a condition which makes fishing uncertain and occasional, therefore unimportant. The other two rivers in which ipon abound are Bangar (also known as the Amburayan) and Baroro Rivers.

The portion along the mouth of Amburayan River coming under the jurisdiction of Bangar belonged formerly to Tagudin. There was for a long time a controversy between the two municipalities as to which should control the ipon fisheries in this section, but recently the controversy was decided in favor of Bangar. From this section, Paratong River, and the portion of the sea-coast which Bangar holds, more ipon are caught than from all other sources in the La Union Province. It has been estimated that in 1928 around 10,000 five-gallon petroleum cans (= 189,250 liters) of ipon were caught in Bangar. This quantity of fresh fish was valued at approximately 30,000 pesos. During the same year, in Baroro River and along the coast of Bacnotan the catch of ipon amounted to 1,000 five-gallon petroleum cans (= 18,925 liters), with an estimated value of about 6,000 pesos.

In Ilocos Sur Province ipon are being caught in great quantities in the Amburayan and the Abra. The former river was for many years the leading fishing center but lost its importance when it changed its course.

Near the mouth of Abra River are the towns of Caoayan and Santa, both noted for ipon fishing. In 1928, the fishery of Caoayan was valued at 18,000 pesos, that of Santa at 15,000 pesos. From fishery license fees collected for the year, the municipality of Caoayan received 2,200 pesos and the municipality of Santa, nearly 2,000 pesos.

The river fisheries of both Caoayan and Santa are divided into lots, which are disposed of at public auction. The municipalities do not prescribe the kind and number of fishing ap-

paratus to be used by the lessee. It is obvious then that under these conditions the fisheries are exploited, and it is feared that, unless the methods are regulated, the capacity of the species to keep up the natural supply may be taxed to the limit, with the result that the fisheries will be ruined through overfishing.

Ipon do not reach the town of Bangued, Abra, until about three weeks after the time they enter the mouth of Abra River. The fish are then about 2.5 to 4 centimeters long. The fishery in this province is not as important and lucrative as in La Union and Ilocos Sur. This can be seen from the following collections for 1928.

Town.	Income from fishing licenses. Pesos.
Bangued (capital of Abra)	5.45
Pidigan	7.00
San Quintin	98.65
Bucay	101.90
Total	213.00

In Ilocos Norte Province ipon fishing is done in Laoag River, but the fishery in the interior is not commercially important. The river passes through the towns of Laoag, San Nicolas, Sarrat, Dingras, Piddig, Solsona, Banna, and Nueva Era. During the rainy season, the river is about a kilometer wide and several meters deep, with a swift current, but in the dry season it is shallow and narrow.

There is, however, considerable fishing at the barrios of La Paz and Gabo, which are located at the mouth of the river and come within the jurisdiction of Laoag. This town has an ordinance which prohibits the setting of traps across the entire width of the river, and provides that there must be a distance of not less than 50 meters from one series of fish traps to the other. The ordinance is an excellent protective measure and Laoag complies with it, but in the interior towns there are no such ordinances for the protection of the ipon and the traps are oftentimes set across the entire width of the river.

From the mouth of Laoag River to the town of Laoag, a distance of about 6 kilometers, seventeen pingis were seen in operation. The ipon that are able to escape from the first pingi have little chance to escape the succeeding traps.

Ipon fishing is a very important industry in Cagayan Province, especially in Aparri, Abulug, and Buguey. The esti-

mated ipon catch of Aparri in 1928 was about 2,500 five-gallon petroleum cans (= 47,302.5 liters), valued at 6,250 pesos. The municipality received during the year an income of about 4,500 pesos from fishing licenses of all kinds. The corresponding catch in Abulug was 2,000 five-gallon petroleum cans (= 37,850 liters), worth around 5,000 pesos, and the licenses for apparatus and fishing rights amounted to almost 850 pesos.

CONSERVATION OF THE IPON FISHERIES

The term "conservation" has been greatly abused and often has become associated in the mind of various people, particularly the fishermen throughout northern Luzon, with oppressive restrictions upon their right of fishing. It is appropriate, therefore, to re-state the true meaning of the term. Conservation implies the fullest and wisest use of nature's wealth without endangering the supply for the future.

That the supply of ipon has been endangered could not be definitely ascertained, for lack of statistical data. But it has been noted that the methods for capture have increased in number, effectiveness, and destructiveness due to ingenuity of construction and operation. The catches are much more now than before and the demand has also become greater, incident to the increase in population.

A study of the existing conditions of the ipon fishery in the Ilocos provinces shows that the people in the interior are economically affected by the intensive fishing through the unregulated use of traps along the coast towns and at the lower courses of streams. Traps are destructive because they are so set as to cover the entire width of streams and as a consequence only a few ipon are able to go to the headwaters to reach maturity. Ipon enter the rivers, move slowly upstream whenever possible, and may approach the traps any time. Because of their slow movement, they may escape the first series of traps only to be caught in the succeeding inclosures.

In regulating the use of traps, a knowledge of their operation is essential. It takes some time to set the bobos properly and even much longer to replace them in position after their removal since the work is done in swift water. A good protective measure would be to leave the middle third of the river open for the free and unimpeded passage of the fish and to fix the distance between any two series of traps at not less than 150 meters. Unless a regulation of this kind is made, this important industry is doomed to perish.

ILLUSTRATIONS

PLATE 1

FIG. 1. Ipon when caught near the mouth of the river; × 2.6.
2. *Sicyopterus lacrymosus* Herre. (Drawing by P. Bravo.)
3. *Ophiocara aporos* Bleeker. (Drawing by M. L. Nievera.)

PLATE 2

FIG. 1. *Glossogobius giurus* (Buchanan Hamilton). (Drawing by M. L. Nievera.)
2. *Glossogobius celebius* (Cuvier and Valenciennes). (Drawing by P. Bravo.)
3. *Chonophorus melanocephalus* (Bleeker). (Drawing by P. Bravo.)

PLATE 3

FIG. 1. *Eleotris melanosoma* Bleeker. (Drawing by J. Nievera.)
2. *Rhyacichthys aspro* (Kuhl and Van Hasselt). (Drawing by A. L. Canlas.)

PLATE 4

FIG. 1. Bobo for catching ipon.
2. Mouth of bobo for catching ipon.

PLATE 5

FIG. 1. Setting bobos to a pingi near the mouth of Laoag River.
2. Finishing a pingi near the mouth of Laoag River.

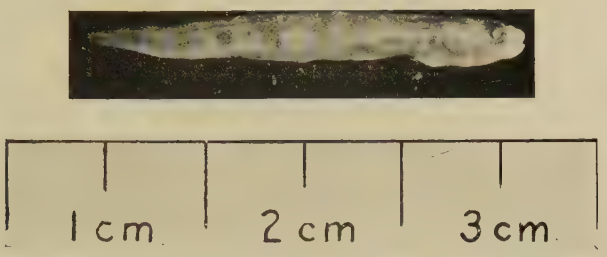
PLATE 6

FIG. 1. Ipon trap, pingi, in operation near the mouth of Laoag River.
2. Setting pamalibtocan, about 1 kilometer from the mouth of Amburayan River.

TEXT FIGURES

[Drawings by A. D. Verzosa.]

FIG. 1. Dip net, caput, used for catching ipon.
2. Diagram of a bobo showing position of inside funnels.
3. Pingi near the mouth of Laoag River.
4. Ipon trap, pingi, in the interior near Sarrat, Ilocos Norte.
5. Ipon trap, padait, near Bangued, Abra.
6. Ipon trap, pamalibtocan, located about 1 kilometer from the mouth of Amburayan River.



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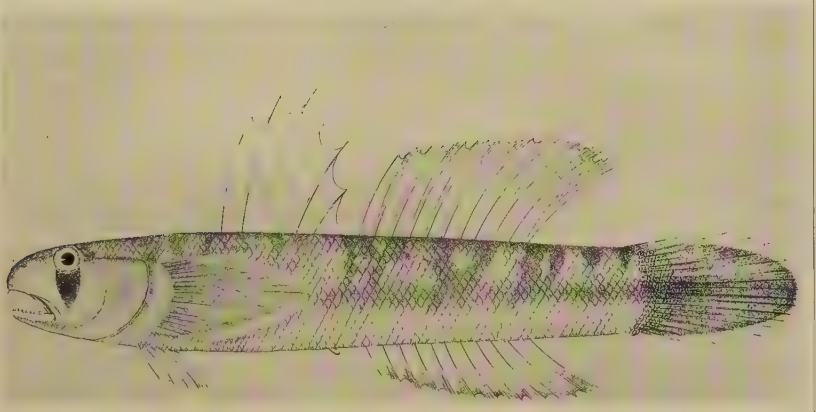

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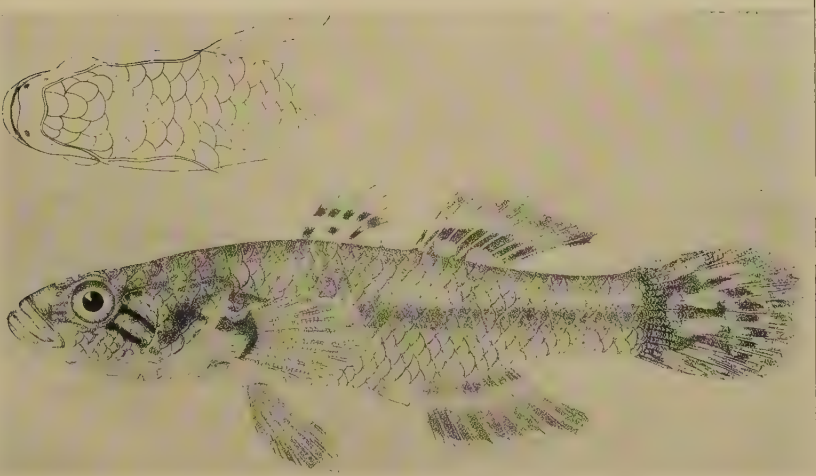

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PLATE 1.

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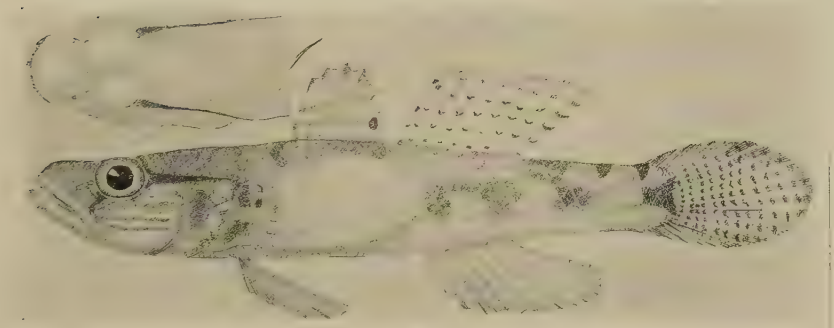

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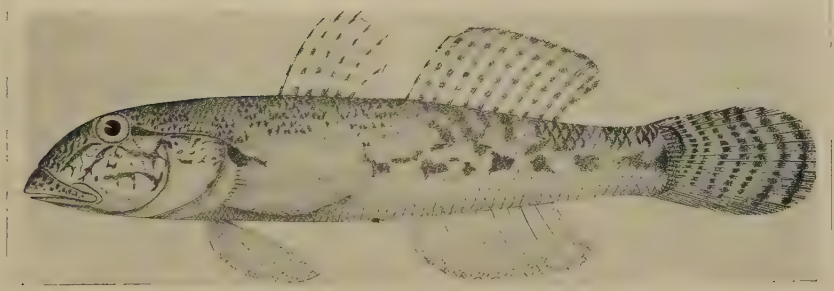

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PLATE 2.

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PLATE 3.

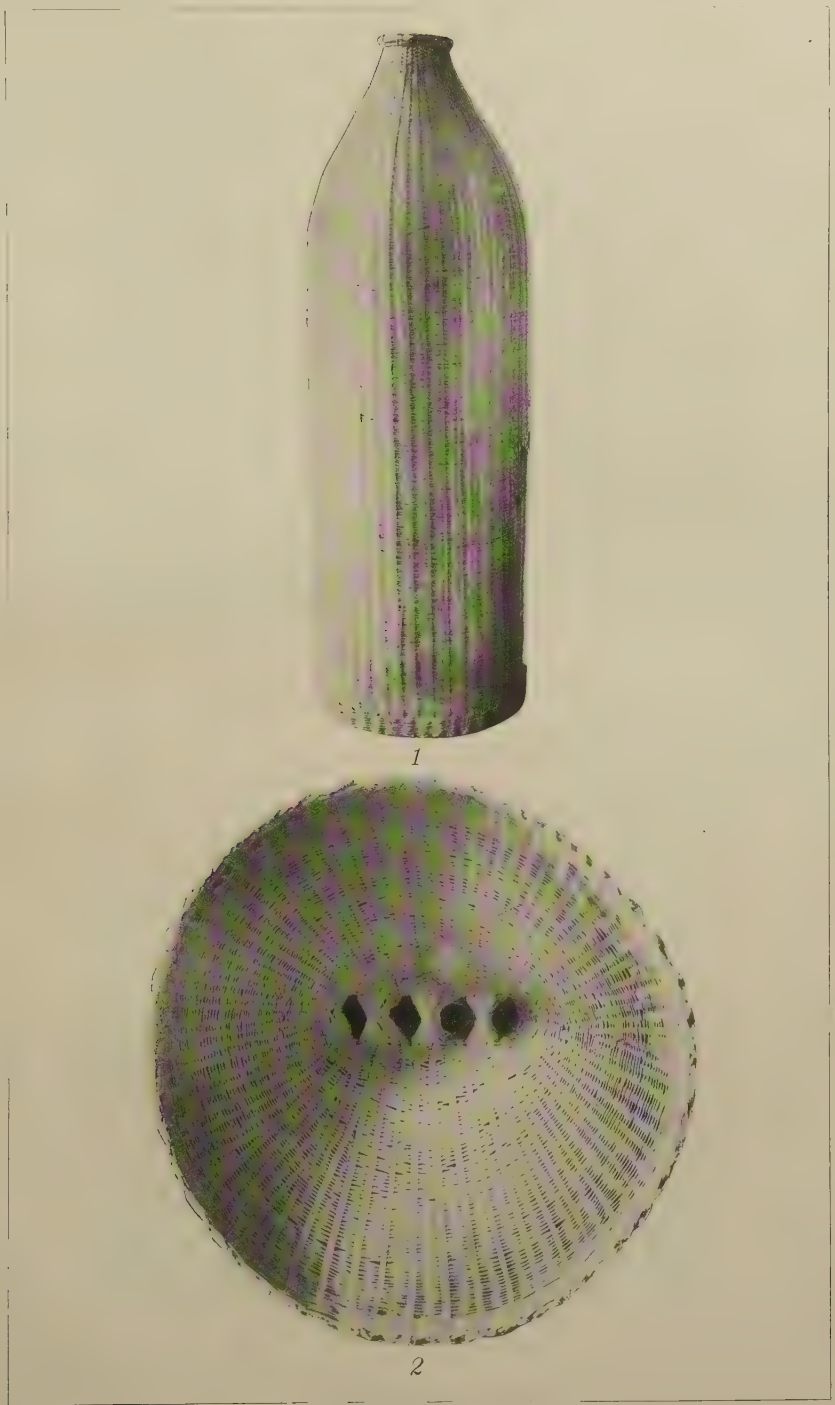

PLATE 4.

1

2

PLATE 5.

1

2

PLATE 6.

LABORATORY TESTS ON THE DURABILITY OF PHILIPPINE WOODS AGAINST FUNGI

By O. A. Reinking
Of the Research Department, United Fruit Company
and
C. J. Humphrey
Mycologist, Bureau of Science, Manila

TWO PLATES

Our present knowledge of the durability of indigenous woods in tropical regions is for the most part limited to a few records of their life under service conditions. These records were taken mainly on railway ties or other structural timbers in contact with the soil. An occasional investigator has carried on laboratory tests, but the woods examined in this way have been comparatively few.

During the period 1919–21 Reinking published a series of five papers [1] listing a considerable number of Philippine wood-destroying fungi and their hosts, the fungi being determined by Patouillard and Lloyd. While these articles do not exhaust the subject by any means, they offer a first modest attempt at recording some of the host relationships of the commoner fungi found on structural wood and timber in the forest.

While decay is but one factor in the destruction of timber, it is, nevertheless, a highly important one, for in the moister parts of the Tropics, with their comparatively high temperature and long growing season, a particularly favorable environment is offered for the development of wood-destroying fungi.

Durability tests in the laboratory offer the advantages of rapid and severe exposure under more or less controlled conditions and of direct comparison of the relative resistance of the materials to the fungi used.

In 1915 Humphrey [2] tested the heartwood and sapwood of greenheart (*Nectandra rodiaei*) against twenty-six species of the commoner fungi prevalent in the United States. Blocks $\frac{5}{8}$ by $\frac{5}{8}$ by 2 inches were partially embedded in sand in test tubes and surrounded by culture blocks of spruce or beech, with sphagnum above. At the end of a year the heartwood blocks were

[1] Philip. Journ. Sci. 15 (1919) 479–490; 16 (1920) 167–179, 527–537; 17 (1920) 363–374; 19 (1921) 91–114.

[2] Mycologia 7 (July 1915) 204–209.

slightly decayed by ten of the fungi, with a maximum loss in weight of 3.8 per cent by *Lenzites trabea* (inadvertently listed as *L. sepiaria* in the published article). The sapwood proved far less resistant, with losses varying from less than 1 per cent to 37 per cent in the case of *Lenzites trabea.*

In 1917 Pfeiffer[3] reported on eight species of woods from the Dutch East Indies. The tests were made by a fermentation method using methane-producing bacteria secured from ditch soil. Ten grams of the powdered wood were placed in 125 cubic centimeter bottles, together with 5 grams calcium chloride and a sufficient solution of di-potassium phosphate, ammonium chloride, and magnesium sulphate to make 0.1 per cent concentration of each of these substances. The contents of the bottle were then thoroughly mixed and inoculated either with a powdered dry culture of the bacteria on cellulose or with an inoculated solution taken from another test bottle. After the bottles had been filled with tap water and fitted with rubber stoppers through which were inserted closed glass tubes for measuring the gas formed, they were incubated at 36° C. for twenty-five days.

The author states that the results secured by this method agree quite well with what is already known regarding the general durability of the species tested, and that those woods which produce a considerable amount of gas will not stand the tropical climate for more than five years.

Data on the eight species reported are arranged as follows, according to their resistance to fermentation:

Total gas produced in twenty-three days (average of three series.)

	cc.
Heartwood.	
Eusideroxylon zwageri	0.3
Tectona grandis	1.2
Shorea sp. (Ressak)	1.35
Dipterocarpus trinervis	16.5
Shorea sp. (Meranti)	33.8
Sapwood.	
Tectona grandis	40.3
Dipterocarpus trinervis	46.8
Not stated whether heartwood or sapwood.[a]	
Alstonia scholaris	6.02

[a] As regards color, gross structure and weight, there is practically no distinction between heart and sapwood in this species.

[3] De waarde von wetenschappelijk onderzoek voor de vaststelling von technische eigenschappen van hout. (The value of scientific research for the determination of the technical properties of timber.) Doctorate Thesis, Amsterdam (1917) 163–188.

In 1921 Schmitz [4] tested the durability of *Ginkgo biloba* by exposing heartwood blocks approximately 1 by 1 by 2 inches in quart Mason jars, six blocks to a jar. These were inoculated with five species of fungi after sterilization at 15 pounds steam pressure for twenty minutes. The results after four months were:

	Loss in weight (per cent).
Polystictus versicolor	3.0
Polyporus lucidus	3.3
Trametes pini	3.6
Fomes roseus	3.6
Fomes pinicola	4.5
Lenzites sepiaria	7.8

The author concludes from these tests that the wood of *Ginkgo biloba* is not unusually resistant to decay under the conditions imposed.

In 1924 Kitajima [5] published a short report in Japanese on the relative durability of a number of American and Japanese timbers, of which only the latter will be mentioned here.

His test was made by placing clear selected heartwood blocks $1\frac{3}{16}$ by $1\frac{3}{16}$ by $4\frac{3}{4}$ inches side by side on a board severely rotted by *Merulius lachrymans* in a moist cellar. The hardwood blocks were oven-dried and weighed before test, but the dry weights of the conifers were computed from the specific gravity and volume, the method of derivation being somewhat obscure in the paper at hand. The results after nineteen months were as follows:

	Loss in weight (per cent).
Thujopsis dolabrata	2
Larix leptolepis	2
Cryptomeria japonica	15
Chamaecyparis obtusa	20
Abies sachalinensis	26
Pinus densiflora	33
Picea ajanensis	37
Tsuga sieboldii	40
Abies firma	40

The original work reported in the present paper was carried out by Reinking during the period 1916 to 1921, at which time

[4] Journ. of Forestry 19 (1921) 165–166.

[5] The writers have seen only a translation of this by Kitajima and cannot cite the original publication. The translated title is, "On the Durability of American Coniferous Woods."

he was plant pathologist at the College of Agriculture, University of the Philippines, Los Baños, Philippine Islands. Flask tests were made on fifteen kinds of Philippine woods and Southern yellow pine from the United States in the following manner, using five named species of fungi, identified mainly by C. G. Lloyd, and nine unnamed cultures of wood-destroying hymenomycetes isolated from various species of local timber.

Wide-mouthed Erlenmeyer flasks of 2 liters capacity were prepared with a quantity of culture blocks, 2 by 2 by 5 centimeters, of nondurable species such as *Erythrina indica, Aleurites moluccana,* and *Pentacme contorta,* among which were mixed the 2 by 2 by 5 centimeter test blocks.

The culture blocks were first boiled in tap water, then immersed in cold tap water until saturated, and finally sterilized for two hours at 10 to 12 pounds pressure in the autoclave. The test blocks were oven-dried for forty-eight hours at 100° C. and then cooled and weighed. The culture flasks were prepared by first placing a layer of water-saturated cotton in the bottom. A triple layer of moist culture blocks as they came from the sterilizer was then placed over the cotton. Alternating layers of test blocks and culture blocks were then put in the flask until it was nearly full. A layer of water-saturated cotton was finally placed over the top of the pile of blocks to hold the moisture. Tap water to about ½-inch depth on the bottom of the flask was added. The flasks were then plugged fairly tightly with absorbent cotton and sterilized on three successive days in the autoclave at 10 to 12 pounds pressure for 60, 45, and 30 minutes, respectively. After sterilization the cotton plugs were trimmed and the tops covered with cloth caps saturated with a 1-to-1000 mercuric chloride solution.

Pure cultures of the fungi to be tested were first grown on bean cultures in test tubes. When the fungus was well established, the bean cultures were poured into the flask, the operation being carried out in a culture case sterilized with mercuric chloride. The flasks were then labelled with the name of the organism, the species of test and culture blocks, and the date of inoculation. They were held in a dust-free case at room temperature for periods varying from seven to twenty-eight months.

At the end of each experiment the character of the fungus growth, the effect on the test blocks and the culture blocks, and the weight of the oven-dried test blocks were recorded. The

loss in weight and the character of the rot produced in the various woods by the specified organisms were in this way determined. The data on these cultures are given in Table 1.

Schneider [6] gives the following durability ratings for the woods [7] herein reported:

Very durable.
- Molave.
- Yakal.

Fairly durable.
- Apitong.
- Guijo.
- Tangile.

Durable.
- Katmon.
- Narra.
- Tabigi.
- Tindalo.

Not durable.
- Lauans.
- Malaanonang.
- Lumbang.

Aroma and dapdap are not rated, although the heartwood is reputed to be durable and the sapwood perishable.

It is seen that the general order of durability derived from the laboratory tests agrees fairly well with the service data published by Schneider. The harder, heavier woods are usually the more durable, but the depth of color of the heartwood bears very little relation to resistance of the wood to fungus attack. Averaging the figures for the different tests which extended over a period of fifteen months or more we arrive at the following losses for the different species or groups:

	Loss in weight (per cent).
Molave	Slight
Yakal	17.5
Tindalo	18.0
Tabigi	21.3
Apitong	27.8
Narra	28.0
Red lauan	42.9
Malaanonang	49.0
White lauan	52.5
Guijo	55.8
Lauan	57.3
Aroma (mostly sapwood)	60.3

It will be noted from the list of scientific names at the end of the paper that the specific identity of the woods tested was not determined in a number of cases, since the same common

[6] Bull. Philip. Bu. Forestry 14 (1916).

[7] Spelling of names is corrected in accordance with Philippine Bureau of Forestry Bulletin 23.

TABLE 1.—*Durability of Philippine woods.*

No.	Organism used.[a]	Duration of test.	Wood.	Oven-dry weight.		Loss in weight.	Remarks.
				Before test.	After test.		
		Months.		*Grams.*	*Grams.*	*Per cent.*	
6966	Undetermined	17	Apitong	25.2	18.2	27.8	Rotted in patches; decay whitish.
6041	do	17	Aroma	12.6	5.0	60.3	Severely decayed and bleached.
2950	*Daedalea flavida* Lév	25¾	Katmon				Severely decayed.
6966	Undetermined	17	Dapdap (culture blocks)				Severely decayed, soft; 3 tests.
7389	*Polyporus sanguineus* L	15¾	do				Severely decayed, rather friable.
5921	Undetermined	16	do				Severely decayed.
5922	do	16	do				Severely decayed, especially at surface.
5924	do	16¼	do				Moderately decayed; too wet.
6718	do	16¼	do				Severely decayed.
6041	do	17	do				Severely decayed, rather friable.
5928	*Polyporus sanguineus* L	16½	do				Do.
5927	*Trametes versatilis* Berk	16¾	do				Very severely decayed, friable.
5955	*Trametes meyenii* Kl	28	do				Completely decayed.
11170	*Polyporus sanguineus* L	9¼	Guijo	49.4	38.9	21.2	Slightly bleached decay in patches; poor growth; 3 blocks.
11605	Undetermined	7	do	43.4	30.0	30.9	Whitish decay in patches.
5927	*Trametes versatilis* Berk	16¾	do	26.0	11.5	55.8	Moderately decayed throughout.
11170	*Polyporus sanguineus* L	9¼	Lauan	21.8	19.7	9.6	Slightly decayed; too wet; 3 blocks.
7389	do	15¾	do	18.0	5.5	69.4	Severely decayed throughout.
11605	Undetermined	7	do	19.2	17.3	9.9	Moderately decayed; too wet.
5955	*Trametes meyenii* Kl	28	do	17.4	9.6	44.8	Severely decayed, soft.
5966	Undetermined	16¼	do				Severely decayed throughout, soft.
5921	do	16	Red lauan	19.2	14.0	27.1	Severely decayed in patches.
5922	do	16	do	20.0	6.1	69.5	Do.
6718	do	16¼	do	26.7	18.9	29.2	Severely decayed; rot whitish; 3 blocks.

5928	*Polyporus sanguineus* L.	16½	do	15.3	7.4	51.6	Severely decayed; soft.
6966	Undetermined	17½	White lauan				Severely decayed.
5926	do	16½	do	19.4	6.7	65.5	Severely decayed throughout; 3 blocks.
5922	do	15¾	do	14.4	8.4	41.7	Severely decayed at surface.
6041	do	17	do	14.4	7.8	45.8	Severely decayed.
5924	do	16¼	White lauan (culture blocks)				Severely decayed throughout.
5926	do	16¼	Lumbang (culture blocks)				Severely decayed throughout, friable.
11605	do	7	do	15.0	9.7	35.3	Severely decayed, soft.
5966	do	16¼	do				Severely decayed throughout.
6966	do	17	Malaanonang	14.5	7.4	49.0	Severely decayed.
3003	*Xerotus nigrita* Lév.	25¾	Molave				Slight decay only in piece on moist cotton.
11170	*Polyporus sanguineus* L.	9¼	Narra	37.5	35.9	4.3	Slightly decayed in patches; 3 blocks.
5922	Undetermined	16	do	18.9	12.4	34.4	Moderately decayed, especially at surface.
6718	do	15¾	do	18.3	11.1	39.3	Moderately to severely decayed.
11605	do	7	do	31.5	28.7	8.9	Slightly decayed.
5926	do	16¼	Narra (heart)	10.0	7.4	26.0	Severely decayed; 2 blocks.
5927	*Trametes versatilis* Berk.	16¾	Narra (light colored)	12.0	11.9	0.8	Slightly decayed in patches.
5927	do	16¾	Red narra	28.5	26.3	7.7	Slight surface rot; wood darkened.
5955	*Trametes meyenii* Kl.	28	do	23.1	15.7	32.0	Moderately to severely decayed; rot whitish.
5966	Undetermined	16¼	do				Slightly decayed.
6966	do	17	White narra	18.7	8.4	55.1	Severely decayed and bleached.
5966	do	16¼	do				Severely decayed throughout.
5921	do	16	Pine				Slightly decayed.
5922	do	16	Pine (boxes from U. S.)	11.6	6.8	41.4	Surface severely decayed.
5924	do	16	Tabigi	20.2	15.9	21.3	Moderately decayed in patches.
2950	*Daedalea flavida* Lév.	25¾	Tangile				Moderately decayed.
5922	Undetermined	16	Tindalo	31.7	26.0	18.0	Moderately decayed and bleached especially at surface.
6966	do	17	Yakal	35.7	19.3	45.9	Moderately decayed.
6966	do	17	do	35.1	26.0	25.9	Severely decayed and bleached, especially at surface.
5926	do	16¼	do	35.0	31.3	10.6	Moderately decayed; 3 blocks.

TABLE 1. *Durability of Philippine woods*—Continued.

No.	Organism used.[a]	Duration of test.	Wood.	Oven-dry weight.		Loss in weight.	Remarks.
				Before test.	After test.		
		Months.		*Grams.*	*Grams.*	*Per cent.*	
5922	Undetermined	16	do	31.1	27.2	12.5	Moderately decayed.
5924	do	16¼	do	20.1	19.6	2.5	Slightly decayed at surface.
5928	*Polyporus sanguineus* L.	16½	do	39.9	38.8	2.8	Do.
7389	do	15¾	do	41.4	34.4	16.9	Do.
5966	Undetermined	16¼	do				Slightly decayed in cracks and at end.

[a] The organisms were isolated from the following hosts; Nos. 2950 and 3003, from bridge flooring, *Shorea guiso;* No. 5921, from dead branch; Nos. 5922 and 5924, from timber, *Pentacme contorta;* No. 5926, from timber, *Shorea guiso;* No. 5927, from railroad tie, *Shorea guiso;* No. 5928, from board *Dipterocarpus grandiflorus;* No. 5955, from stump, *Cordya myxa;* No. 5966, from railroad tie, *Shorea guiso;* No. 6041, from dead branch; No. 6718, from dead wood, *Parashorea plicata;* No. 6966, from rotten log; No. 7389, from timber, *Quercus* sp.; No. 11170, from building material; No. 11605, from dead wood. NOTE: The scientific names for the woods tested are given, as far as possible, at the end of the article.

name may be commercially applied to different species within the same genus or even to particular species in different genera. The physical characteristics determine the local grouping, but this does not imply that there may not be differences in chemical constitution which would affect the durability.

For the benefit of those not familiar with tropical woods, brief descriptions may aid in interpreting the above data. These descriptions are largely condensed from statements in Bureau of Forestry Bulletin 15.

MOLAVE is a hard, heavy wood with a specific gravity up to 0.880; heartwood pale straw color to light brown, sometimes with greenish tints; lime water or other alkalis stain it bright greenish yellow; chips give yellow color to water; sapwood small, scarsely lighter than heartwood.

YAKAL is a trade name for several species of *Hopea, Shorea,* and *Isoptera.* Yakal proper is *Hopea plagata. Hopea* woods are hard to very hard, tough, heavy, with a specific gravity up to 0.834; heartwood pale yellow to light yellowish brown, darkening rapidly on exposure, sometimes with narrow, irregular greenish streaks which in drying turn greenish black; sapwood 2 to 8 centimeters thick, pale yellow when fresh, often staining to a dirty gray, rather sharply distinguished from heartwood.

Yakals of the *Shorea* and *Isoptera* groups are somewhat coarser textured than those of the *Hopea* group, otherwise they have about the same characteristics.

TINDALO is a hard, heavy wood, with specific gravity up to 0.878; heartwood saffron or pale orange, turning with age to a deep rich red, sometimes with irregular blackish streaks; odor of raw beans or peanuts; sapwood 2 to 4 centimeters thick, white, perishable.

TABIGI is a tree of the mangrove swamps, with a moderately hard and moderately heavy wood; heartwood light red to deep wine color; sapwood small, whitish, rather perishable.

APITONG yields a moderately hard to hard, moderately heavy to heavy wood, with a specific gravity up to 0.645; heartwood light ashy red to reddish brown or dark brown; resinous odor; sapwood 2 to 8 centimeters, light grayish or brownish when fresh, not sharply delimited from heartwood.

NARRA is a moderately hard to hard, moderately heavy wood, with specific gravity up to 0.580; heartwood ranges from pale straw color through all possible shades of pink, salmon, and red to deep blood red and occasionally dull brown without any red

tint; as far as known, all species of *Pterocarpus* may produce wood of any color, the commercial classification of "red," "yellow," and "white" narra being applicable only after the tree is felled and sawn; sapwood 2 to 8 centimeters, whitish, perishable.

LAUANS. Species in at least five genera are included under this name.

RED LAUAN is a soft to moderately hard, light to moderately heavy wood, with specific gravity up to 0.542; coarse textured and cross-grained; heartwood light red to dark reddish brown; sapwood 3 to 5 centimeters, reddish or brownish white, not sharply delimited from heartwood.

WHITE LAUAN wood is soft to moderately hard, light to moderately heavy; heartwood pale grayish brown to light reddish brown; sapwood whitish, turning pale silvery gray in drying, but often staining to dirty grayish brown, not sharply delimited from heartwood.

MALAANONANG produces a wood of the lauan type, light and soft heartwood pale brown; sapwood small, somewhat paler than heartwood.

GUIJO has a moderately heavy to heavy, moderately hard to hard wood, with specific gravity up to 0.708; heartwood light ashy brown to brown, sometimes with distinct reddish tint; faint odor of resin; sapwood 2 to 5 centimeters, light grayish brown, not sharply delimited from heartwood.

KATMON wood is hard and heavy, with a specific gravity up to 0.816; heartwood light brick red to dark reddish brown; sapwood pale red, not sharply delimited from heartwood.

LUMBANG produces a light, soft, whitish wood, with no distinction between sapwood and heartwood.

TANGILE wood is the hardest, finest-textured and, with the exception of red lauan, the darkest red of the lauan class; soft to moderately hard and light to moderately heavy, with a specific gravity up to 0.509; heartwood pale red to dark reddish brown; sapwood 2 to 5 centimeters, pale grayish brown, not sharply delimited from heartwood.

DAPDAP is a very light corky wood often used for floats and buoys; sapwood and heartwood not distinguishable by gross characteristics.

AROMA has a yellowish brown, moderately hard and heavy heartwood, more durable than the rather large, whitish sapwood.

Little is known regarding the substances in wood which render it resistant to fungus attack. In general, it is assumed, with considerable experimental evidence, that this resistance resides largely in toxic substances within the wood. In the case of highly resinous woods, however, the action of the toxic constituents in the resin is undoubtedly supplemented by a waterproofing action of the resinous materials.

Wehmer [8] has shown that the extractives from European oak, consisting largely of tannin bodies, are in part responsible for the durability of that species. Investigations reported [9] from the Forest Products Laboratory also indicate that the hot-water extractives from the heartwood of such highly durable species as catalpa (*Catalpa speciosa*), red mulberry (*Morus rubra*), black locust (*Robinia pseudo-acacia*), white oak (*Quercus alba*), etc., may totally, or almost completely, inhibit the growth of *Fomes annosus* in a 50 per cent [10] concentration; or even in 10 per cent concentration in the case of black locust and red mulberry. While these are very high concentrations when compared with an effective antiseptic, nevertheless the experiments show that the extractives are poisonous to a considerable degree in some cases.

The constitution of these extractives is little understood. Chestnut (*Castanea*), oak, black locust, and mulberry are known to contain tannin. Osage orange (*Toxylon pomiferum*), black walnut (*Juglans nigra*), and redwood (*Sequoia sempervirens*) contain large quantities of soluble coloring matter of unknown composition. From greenheart (*Nectandra rodiaei*) at least four alkaloids have been isolated from the wood and bark. Certain conifers, such as the cedars, cypress, etc., contain volatile oils which are known to be toxic. Bateman [11] thinks that the terpenes and terpineols (pine oils), contained in the resins of pines and certain other conifers, are important in durability when in sufficient quantity to be effective. Kitajima [12] has tested the extracted oil of *Thujopsis dolabrata*, one of the very

[8] Mycol. Centralbl. 1 (May, 1912) 138–148; 1 (June, 1912) 166–174.

[9] Hawley, L. F., L. C. Fleck, and C. A. Richards, Journ. Ind. and Eng. Chem. 15 (July, 1924) 699.

[10] The total extractive from 100 grams of wood is concentrated to 100 cubic centimeters, and then diluted to one-half.

[11] Southern Lumberman 115 (July 5, 1924) 51.

[12] Forest Experiment Station [Meguro, Tokyo, Japan] Bull. 17 (September, 1917).

durable woods of Japan, and found that 0.05 per cent concentration in agar prevented the growth of *Poria vaporaria*, while from 0.25 to above 0.50 per cent of turpentine oil and the oils from *Chamaecyparis obtusa* and *Chamaecyparis pisifera*, were required.

It appears, then, that the effective toxic constituents in wood vary widely, the tannin groups being important in many species, essential oils (sometimes rather high-boiling) in many conifers, and alkaloids in certain other species. As the chemistry of wood becomes better known many constituents will undoubtedly come to light.

SUMMARY

The paper presents data on the resistance to decay of fifteen kinds of common Philippine woods and a species of southern yellow pine from the United States. These were tested against five named species and nine unnamed ones of common and destructive Philippine fungi. Small blocks of wood were inserted in 2-liter Erlenmeyer flasks, inoculated, and allowed to decay for periods varying up to twenty-eight months, but for the most part sixteen to seventeen months. The severity of decay is indicated by loss in weight as well as by the physical condition when removed from the flasks. The relative scale of durability derived accords well with the published records of the resistance of the same woods to fungus attack under natural or service conditions, molave (*Vitex*), yakal (*Hopea* etc.), and tindalo (*Pahudia*) leading the list for durability, while the softer woods, such as the lauans (*Shorea, Parashorea, Pentacme*), guijo (*Shorea*), katmon (*Dillenia*), dapdap (*Erythrina*), and malaanonang (*Shorea*) are quite perishable under conditions favorable to decay. Narra (*Pterocarpus*) and apitong (*Dipterocarpus*) proved moderately durable.

SCIENTIFIC NAMES OF PHILIPPINE WOODS TESTED BY REINKING FOR DURABILITY

Apitong. *Dipterocarpus grandiflorus* Blco. and *D. vernicifluus* Blco.
Aroma. *Acacia farnesiana* (L.) Willd.
Katmon. *Dillenia philippinensis* Rolfe and *D. luzonensis* (Vid.) Mart.
Dapdap. *Erythrina variegata* Linn.
Guijo. *Shorea guiso* (Blco.) Blm.
Red lauan. *Shorea negrosensis* Foxw. and other *Shorea* species with wood of the same type.

White lauan. *Pentacme contorta* (Vid.) Merr. and Rolfe, *Parashorea malaanonan* (Blco.) Merr. and *Shorea eximia* (Miq.) Scheff.
Lumbang. *Aleurites moluccana* Willd.
Malaanonang. *Shorea polita* Vid.
Molave. *Vitex parviflora* Juss.
Narra.
Red narra. *Pterocarpus indicus* Willd.
White narra. *Pterocarpus vidalianus* Rolfe.
Pine. Southern yellow pine group from the United States.
Tabigi. *Xylocarpus granatum* Koen.
Tangile. *Shorea polysperma* (Blco.) Merr.
Tindalo. *Pahudia rhomboidea* (Blco.) Prain.
Yakal. *Hopea plagata* (Blco.) Vid., *Isoptera borneensis* Scheff., and *Shorea balangeran* (Korth.) Dyer.

ILLUSTRATIONS

PLATE 1. CULTURES IN LARGE ERLENMEYER FLASKS

FIG. 1. *Xerotus nigrita* Lév., No. 3003, 25¼ months.
2. *Trametes meyenii* Kl., No. 5955, 27¾ months.
3. *Polyporus sanguineus* L., No. 5928, 16 months.
4. *Trametes versatilis* Berk., No. 5927, 16½ months.
5. *Daedalea flavida* Lév., No. 2950, 25¼ months.
6. Undetermined fungus, 16½ months.
7. Undetermined, No. 5924, 15¾ months.
8. Undetermined, No. 6966, 16½ months.
9. Undetermined, No. 5922, 15½ months.

PLATE 2

FIG. 1. *Daedalea flavida* Lév. No. 2950, lower surface of sporophore. Natural size.
2. Undetermined polypore. Natural size.

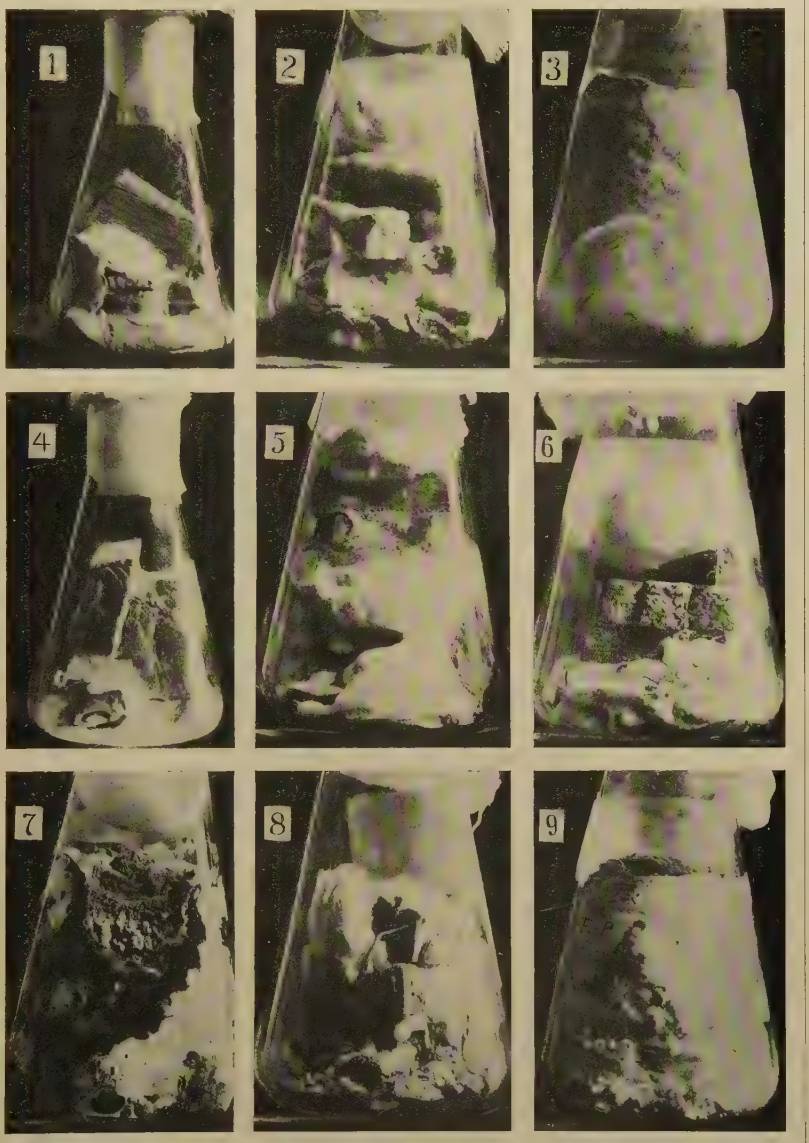

PLATE 1.

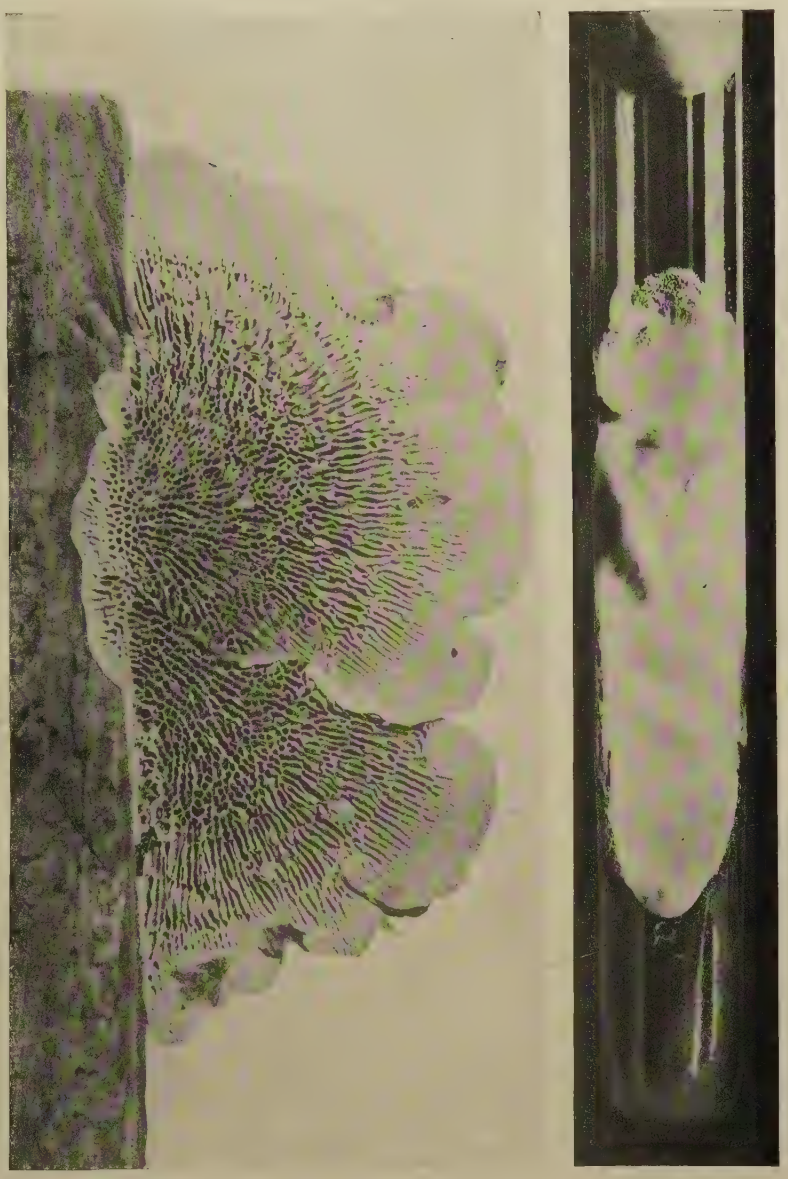

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PLATE 2. DAEDALEA FLAVIDA LÉV.

THE RESISTANCE AND THE BLOOD SUGAR OF ANIMALS INFECTED WITH TRYPANOSOMA EVANSI

By Marcos A. Tubangui

Of the Division of Biology and Serum Laboratory Bureau of Science, Manila

and

Lope M. Yutuc

Of the College of Veterinary Science, University of the Philippines, Los Baños, Laguna

SEVEN TEXT FIGURES

The pathological processes that ultimately cause the death of animals infected with pathogenic trypanosomes have been explained in different ways. Some believe that they are due to the liberation of a toxic substance by the disintegrating organisms. Reichenow (1921) finds support for this view by the observation that in sleeping sickness the temperature reaches its maximum height after the disappearance of the parasites from the peripheral circulation. The experience of Edwards (1926) as well as our own on the fatal results that often follow the injection of tartar emetic in horses affected with surra when the trypanosomes are very abundant in the circulation, is also a point in favor of the toxin theory.

Kligler, Geiger, and Comaroff (1929), on the other hand, are of the opinion that "the pathological processes are engendered by the metabolism of the trypanosomes which results in the rapid production of lactic acid, leading to exhaustion of the alkali reserve and probably also to a depression of the oxidative processes by the specific effect of lactic acid on the hæmoglobin."

Another explanation is that given by Schern (1925, 28) and Fenyvessy (1926), who ascribe the pathogenicity of trypanosomes to a disturbance of the sugar metabolism of infected animals. They have reported the results of experiments in which it was shown that the amount of dextrose in the blood was decreased in proportion to the number of organisms present

in the blood (Schern) or to the progress of the infection (Fenyvessy). They believe that the low blood-sugar content, or hypoglycæmia, is the immediate cause of death and is brought about by the metabolism of the blood sugar by the parasites, since in experiments in vitro they observed the utilization of this carbohydrate by the parasites. Later Yorke, Adams, and Murgatroyd (1929) also showed that trypanosomes suspended in serum consume large quantities of dextrose. Bruynoghe, Dubois, and Bourkaert (1927) confirmed Schern's work in so far as the hypoglycæmia is concerned, but they maintained that the trypanosomes do not consume the sugar of the blood directly but only serve to reduce its titre by the production of an insulinlike substance.

The observations of Schern and of Fenyvessy have generally been accepted and only Zotta and Radacovici (1929 *a*, *b*) have differed from them. The latter studied the blood sugar of guinea pigs infected with *Trypanosoma brucei* and their conclusions, as summarized by Yorke (1930), are the following:

1. In guinea pigs infected with nagana a progressive hypoglycaemia, proportional to the increasing number of trypanosomes in the blood, was not observed.

2. The variations of the degree of glycaemia were irregular, sometimes above and sometimes below the normal, suggestive of a disorder of the sugar-regulating centre, but in no case of a direct utilization of the blood glucose by the trypanosomes.

3. On the contrary, the constant phenomenon in the evolution of trypanosomiasis is a pre-mortal hypoglycaemia.

4. This appears quite suddenly without any previous progressive diminution in the blood sugar; in fact, it is more often preceded by a phase of hyperglycaemia.

5. The terminal hypoglycaemia is perhaps due to a nervous mechanism set in motion by the direct action of the trypanotoxin on the sugar-regulation centre or by an indirect action through the suprarenal capsules.

6. Moreover, terminal hypoglycaemia is not specific for trypanosomiasis. It is a biological state characterizing the pre-mortal period of a large number of diseases.

These views on the causation of injury and death in trypanosomiasis, supported as they are by either clinical or experimental evidence, are significant from the viewpoint of chemotherapy. Hence, while engaged in studies on the treatment of surra, we availed ourselves of the opportunity to study the blood sugar of animals infected with the disease. At the same time counts were made on the number of trypanosomes in the peripheral circulation and the rate of multiplication and increase

of the parasites were estimated in order to find out if, as claimed by Schern and by Fenyvessy, the quantity of the blood sugar varies in inverse proportion to the number of trypanosomes or to the progress of the infection; and, if this should prove to be the case, to determine if the resistance of certain animals has anything to do with their ability to maintain a normal blood-sugar content.

MATERIALS AND METHODS

Animals used.—Previous studies on the blood sugar in experimental trypanosomiasis have mostly been carried out on particular groups of animals only. In as much as different species of hosts may respond differently to the presence of the same species of trypanosome, the following were utilized in the present studies; namely, white rats, guinea pigs, cats, dogs, and horses. These were inoculated subcutaneously with a strain of *Trypanosoma evansi* isolated from a surra horse and maintained in the laboratory by direct passage through guinea pigs. Before an animal was infected or during the incubation period of the disease, one or more sugar determinations were made to serve as controls. After the appearance of the parasites in the peripheral circulation, the sugar readings were made daily or every two days, the number of trypanosomes in the blood counted, and the rate of multiplication of the parasites estimated.

Determination of the blood sugar.—The sugar determinations were made according to the new method of Folin (1928). The blood samples were obtained from the veins of the ear in horses, dogs, and cats; from the veins of the abdomen or legs of guinea pigs; and from the tail or legs of rats. The determinations were made in most of the cases between 11 and 12 o'clock in the morning.

Estimation of the resistance of host animals.—The method of Taliaferro and Taliaferro (1922) for measuring the resistance of animals against trypanosome infections was adopted. For the details of the method the original paper should be consulted. Briefly, however, it consists in counting the parasites in the blood at repeated intervals from the day they become visible in the peripheral circulation and at the same time estimating their coefficient of variation as a measure of their reproductive activity. The rationale of this method is based on the fact that the variability of size in a population of organisms in which

there is active reproduction with the consequent production of young and intermediate stages, is greater than in a population in which there is little or no reproduction and in which the members are all, therefore, more or less full-grown adults. As Taliaferro (1929) puts it,

> Granted that a parasite not only has successfully invaded its specific host but has started reproduction, it is evident that if no resistance is operative the number of parasites must increase in the blood at a uniform rate. Also, due to the fission method of protozoan reproduction such an unmolested increase would cause the number to accumulate according to a geometrical progression series (a, ar, ar^2, ar^3, ar^4 . . . ar^n, for example, 1, 2, 4, 8, 16 etc.) If it does not progress uniformly in this manner, (and the majority of infections do not), for example, if after the parasite has appeared in the host as an infection, its numbers either remain constant or decrease, it may be concluded that some type of resistance is operative.

DISCUSSION OF RESULTS

The results obtained in the different groups of animals were so uniform that it will suffice to cite one or two representative cases in each group from which to draw conclusions.

Rats.—Ten white rats were infected. Incubation period, four to five days; duration of infection (that is, from the time the trypanosomes were first visible in the peripheral circulation until the host animal died), four to six days. For the other data, figs. 1 and 2 may be consulted.

It will be seen from the figures that in rats surra runs a continuous progressive course, the trypanosomes never leaving the peripheral circulation after they have effected their entrance. On the other hand they undergo rapid multiplication, as evidenced by their coefficient of variation which is always high, as a result of which they increase in number. In the beginning of the infection the increase is usually slow and gradual, but towards the end it becomes so rapid that at the time of, or shortly before, the death of the host there may be from 650,000 to 1,000,000 trypanosomes per cubic millimeter of blood. This behavior of the organism is in conformity with the contention of Kligler and Comaroff (1929) that rats possess a certain degree of resistance against *T. evansi.* This resistance, the nature of which is still a matter of conjecture, manifests itself during the first two or three days after the appearance of the organisms in the peripheral circulation when their number is kept at a low level (2,000 to 140,000 trypanosomes per cubic millimeter of blood). After that time, it breaks down, and the

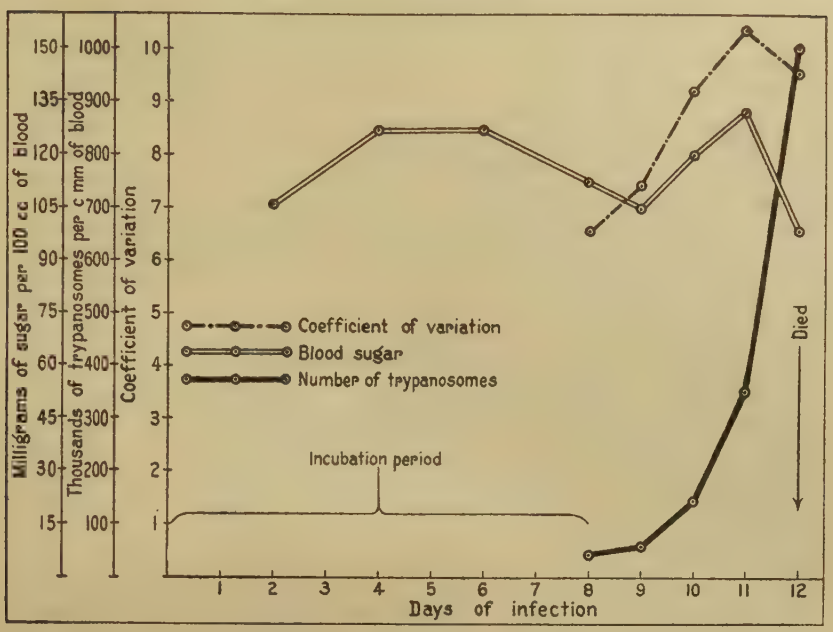

FIG. 1. Blood sugar and the course of infection in rat 2.

number of the parasites in the blood quickly reaches the maximum and the host animal dies.

With reference to the blood sugar, our findings are in accord with those of Zotta and Radacovici in that none of our rats developed the condition of progressive hypoglycæmia. The data of rat 2, as shown in fig. 1, are characteristic for the majority of animals, the dextrose content of the blood remaining normal throughout (at least 100 milligrams per 100 cubic centimeters of blood). Only in one rat, No. 7, as shown in fig. 2, was there a diminution in the amount of blood sugar and this occurred on the day the animal died. In fact, the animal died in less than two hours after its blood had been obtained for sugar determination; the sugar reading was 45 milligrams per 100 cubic centimeters of blood. The condition is, therefore, what Zotta and Radacovici call a premortal hypoglycæmia, which occurs, according to these authors, not only in trypanosomiasis but also in several other diseases.

Guinea pigs.—Three guinea pigs were infected. Incubation period, six to ten days; duration of infection, fifty-four to ninety-five days. For the other data, fig. 3, based on the records of guinea pig 1, may be consulted.

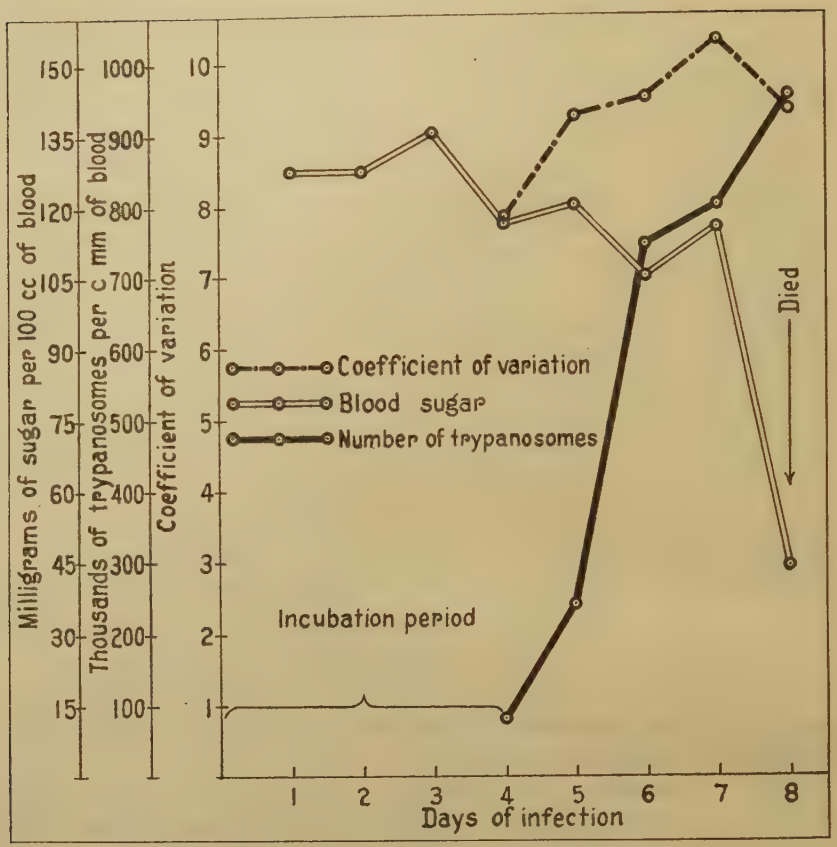

FIG. 2. Blood sugar and the course of infection in rat 7.

The figure shows the generally well-known fact that in guinea pigs infection with surra is of long duration and of the relapsing type; that is, there are times following the initial incubation period when the parasite, after it has started to multiply, may either be greatly reduced in numbers or disappear altogether from the peripheral circulation only to be seen again and to increase in number after so many days. These crises and relapses, as they are called, may be repeated a number of times. As in the case of the rat, however, the coefficient of variation remains constantly high, an indication that there is no abatement of the rate of multiplication. This being the case, the fluctuations in the numbers of the parasite may be explained by assuming that the guinea pig possesses a mechanism of resistance which when functioning in good order, brings about the de-

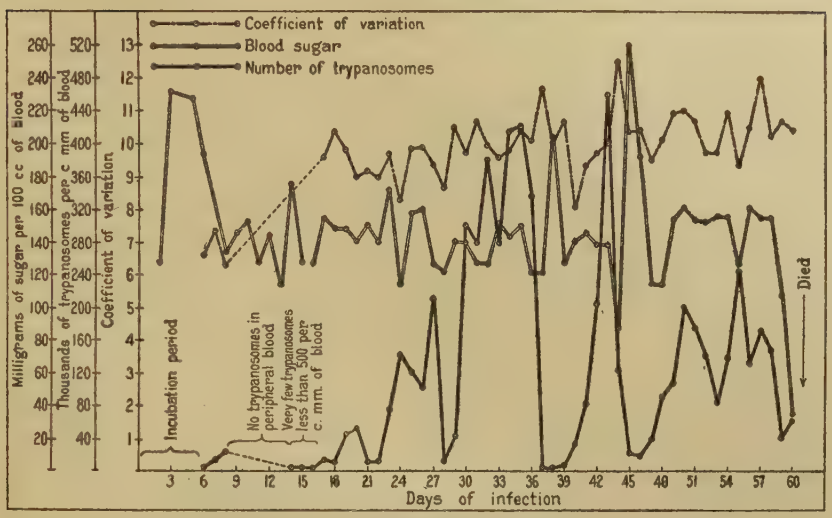
Coefficient of variation
Blood sugar
Number of trypanosomes
Milligrams of sugar per 100 cc of blood
Thousands of trypanosomes per c. mm of blood
Coefficient of variation
Incubation period
No trypanosomes in peripheral blood
Very few trypanosomes less than 500 per c. mm. of blood
Died
Days of infection

FIG. 3. Blood sugar and the course of infection in guinea pig 1.

struction of trypanosomes to the extent that they become so scarce at times that it is difficult or even impossible to detect them in the peripheral blood. In this respect and also in the fact that the same phenomenon may occur a number of times before the host animal succumbs, is the resistance of the guinea pig superior to that of the rat. What finally brings about the fatal end in these animals is not very clear, for at the time of, or sometime before death the number of trypanosomes in the circulation is usually not large.

The observations on the blood sugar were similar to those in rats in that only a terminal hypoglycæmia was registered in all the three animals studied. The dextrose reading during the infection was mostly between 100 and 200 milligrams per 100 cubic centimeters of blood. On two occasions, in the case of guinea pig 1, it even went up much beyond the 200 limit, thus presenting the reverse picture, namely, hyperglycæmia.

Cats.—Three cats were infected. Incubation period, six to eleven days; duration of infection, four to thirty-two days. For the other data, figs. 4 and 5 may be consulted.

It is apparent from the figures that in cats surra may be either an acute disease similar to that seen in rats (cat 1, fig. 4; also cat 2) or a chronic relapsing infection that possesses some of the characteristics of that observed in guinea pigs (cat 3, fig. 5). In the latter case, although the trypanosomes

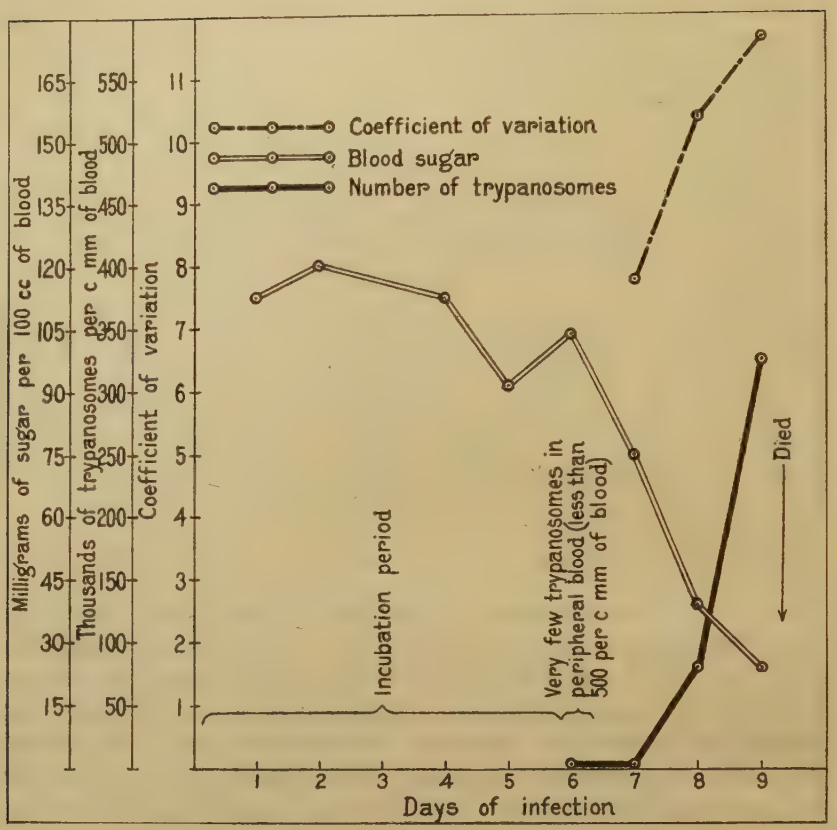
Milligrams of sugar per 100 cc of blood
Thousands of trypanosomes per c mm of blood
Coefficient of variation
Coefficient of variation
Blood sugar
Number of trypanosomes
Incubation period
Very few trypanosomes in peripheral blood (less than 500 per c mm of blood)
Died
Days of infection

FIG. 4. Blood sugar and the course of infection in cat 1.

never completely disappeared from the peripheral circulation, there were one or two instances during the infection when the organisms, after their successful multiplication, were greatly reduced in numbers. In all of the cases, however, death was the ultimate outcome and this occurred when the number of parasites in the blood had reached a maximum (322,000 to 850,000 trypanosomes per cubic millimeter of blood).

With respect to the blood sugar, the results were also contradictory. In cats 1 and 2 a progressive hypoglycæmia developed soon after the entrance of the organisms into the general circulation. During the incubation period of the infection the sugar readings of each of these two animals averaged a little over 100 milligrams per 100 cubic centimeters of blood; after that time there occurred a gradual diminution so that shortly

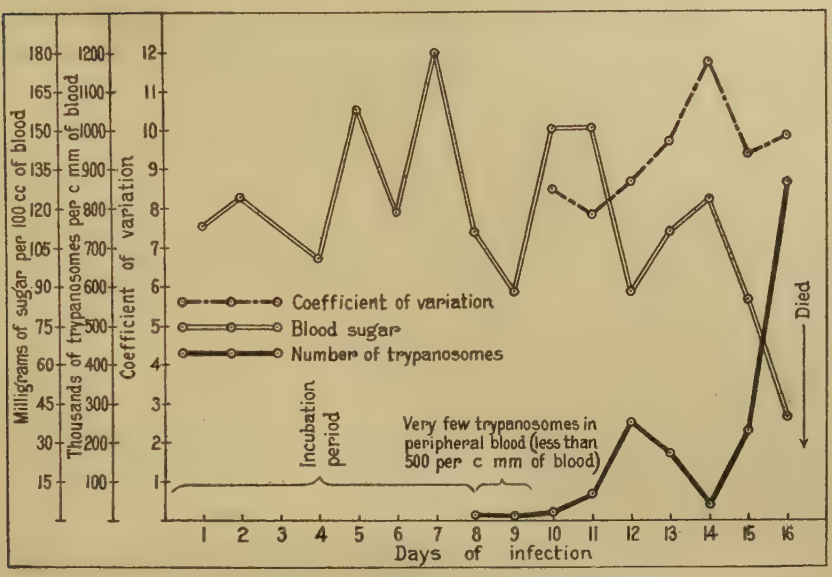
Milligrams of sugar per 100 cc of blood
Thousands of trypanosomes per c mm of blood
Coefficient of variation
Coefficient of variation
Blood sugar
Number of trypanosomes
Incubation period
Very few trypanosomes in peripheral blood (less than 500 per c mm of blood)
Died
Days of infection

FIG. 5. Blood sugar and the course of infection in cat 3.

before death the readings were only 26 and 34 milligrams, respectively, per 100 cubic centimeters of blood.

The contradictory results obtained in cats would have been difficult to explain had it not been for the following observation. Soon after the appearance of the trypanosomes in the general circulation of cats 1 and 2, these animals began to evacuate bloody fæces, which on examination revealed the presence of numerous coccidial oöcysts (*Isospora bigemina*). These cats had previously been examined and found to be lightly infested with coccidia, but they did not show any symptoms of coccidiosis till after they had been successfully infected with surra. It is to be presumed, therefore, that the trypanosomes, perhaps by lowering the resistance of the host animals, induced the rapid multiplication of the coccidial parasites, as a result of which the cats showed acute symptoms of coccidiosis. It may also be inferred that the two diseases, trypanosomiasis and coccidiosis, must have been jointly responsible in bringing about the condition of progressive hypoglycæmia and causing the early death of cats 1 and 2. Otherwise, trypanosomiasis alone, as shown in the case of cat 3, runs a chronic relapsing course and it either brings about no changes in the dextrose content of the blood or produces only a terminal hypoglycæmia.

Dogs.—Two dogs were inoculated. Incubation period, six to ten days; duration of infection, sixteen to thirty-two days. For the other data, fig. 6 may be consulted.

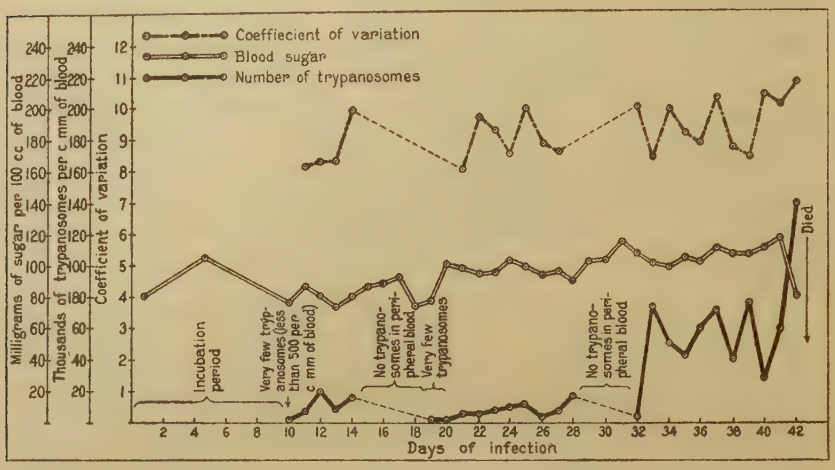
Coeffiecient of variation
Blood sugar
Number of trypanosomes
Milligrams of sugar per 100 cc. of blood
Thousands of trypanosomes per c mm of blood
Coefficient of variation
Incubation period
Very few trypanosomes (less than 500 per c mm of blood)
No trypanosomes in peripheral blood
Very few trypanosomes
No trypanosomes in peripheral blood
Died
Days of infection

FIG. 6. Blood sugar and the course of infection in dog 1.

It will be seen that in dogs surra also runs a chronic relapsing course, the infection being characterized, as in guinea pigs, by intermittent periods, during which no parasites are visible in the peripheral circulation. Towards the end, however, after the resistance of the hosts has apparently been used up, the infection follows a course similar to that which takes place in rats; that is, there is a rapid increase in the number of the organisms and the animals die when that number has reached its maximum (142,000 to 852,000 trypanosomes per cubic millimeter of blood). In this respect the infection in the dog differs from that in the guinea pig, for in the latter death usually takes place when the parasites in the circulation are scanty.

The observations on the blood sugar are similar to those in the other groups of animals. In dog 1 (fig. 6) the sugar readings were between 80 and 111 milligrams per 100 cubic centimeters of blood throughout the infection, while in the other dog there was only a terminal hypoglycæmia.

Horses.—Four horses were infected, but we have complete records on only one of them. Incubation period, four to seven days; duration of infection, thirteen days for horse 2 with complete records. For the other data, fig. 7 may be consulted.

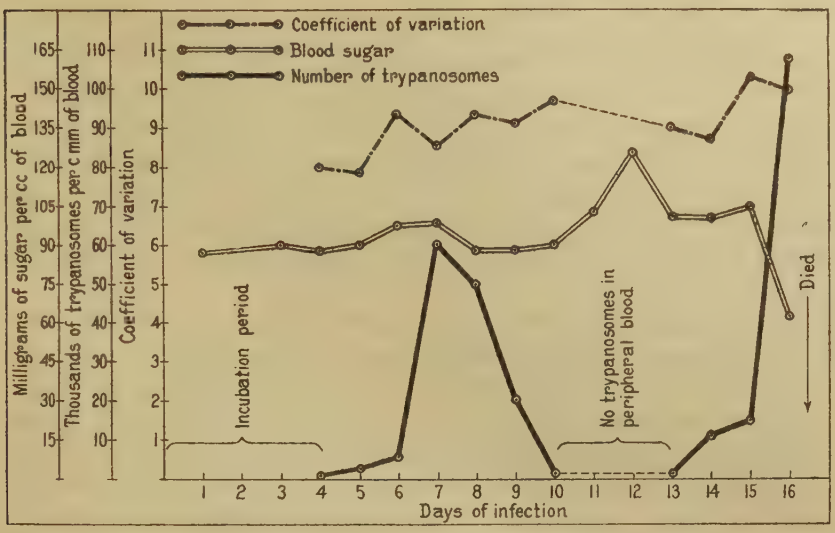

FIG. 7. Blood sugar and the course of infection in horse 2.

It is shown that the character of the infection in the horse is quite similar to that in the dog. It runs a relapsing course, and death takes place when the parasites are most numerous in the circulation.

In common with the other animals studied, the only effect of the infection on the sugar content of the blood was the production of a terminal hypoglycæmia.

SUMMARY AND CONCLUSIONS

The resistance and the blood sugar of rats, guinea pigs, cats, dogs, and horses infected with surra were studied. The resistance was measured according to the method of Taliaferro and Taliaferro (1922), and the sugar determinations were made by the "micro" method of Folin (1928).

In common with the findings of Knowles and Das Gupta (1928), varying degrees of resistance were exhibited by the different animals studied, as indicated by their ability to keep in abeyance for a shorter or a longer period of time the rapid and permanent proliferation of the surra organism. Thus, on the one hand, the rat possesses a low type of resistance, for in this animal the infection runs an acute progressive course, the parasites undergoing a constant increase in number and death taking place when the number of the parasites in the blood has

reached a maximum. The guinea pig, on the other hand, possesses a high type of resistance, for in this animal the infection follows a chronic relapsing course and death usually occurs when the parasites are scanty in the circulation. The resistance of the cat, the dog, and possibly the horse is of an intermediate type, for in these animals the infection is, as in the guinea pig, chronic and relapsing in nature; but, as in the case of the rat, death occurs when the parasites are most numerous in the peripheral circulation.

No evidence was obtained to show that resistance against surra is dependent on the ability of the host animal to maintain a normal blood-sugar content.

In the majority of cases, irrespective of the kind of animal studied, no appreciable changes in the sugar content of the blood were observed during the course of the infection, except at the very end when a terminal or agonal hypoglycæmia was usually detected. In two cats the disease followed an abnormally acute course and was characterized by a progressive hypoglycæmia due, however, to the fact that in these particular animals the infection was complicated with coccidiosis.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Blood sugar and the course of infection in rat 2.
2. Blood sugar and the course of infection in rat 7.
3. Blood sugar and the course of infection in guinea pig 1.
4. Blood sugar and the course of infection in cat 1.
5. Blood sugar and the course of infection in cat 3.
6. Blood sugar and the course of infection in dog 1.
7. Blood sugar and the course of infection in horse 2.

TREMATODE PARASITES OF PHILIPPINE VERTEBRATES, IV. ECTOPARASITIC FLUKES FROM MARINE FISHES

By Marcos A. Tubangui

Of the Division of Biology and Serum Laboratory
Bureau of Science, Manila

THREE PLATES

A heavy mortality among the marine fishes in the aquarium of the Bureau of Science in Manila was registered recently and attempts to discover the cause resulted in the finding by Mr. C. Martin, of the division of fisheries, Bureau of Science, of a small trematode on the gills of affected fishes. Because of the suspicion that the fluke might have been responsible for this mortality, the writer was requested to look over the remaining fishes in the aquarium and to determine their parasites, if any be encountered.

With the coöperation of Mr. Martin, representatives of the following three species of fishes, which, at the time of our visit to the aquarium, showed signs of disease, were examined: *Anyperodon leucogrammicus* (Valenciennes) Bleeker, *Teuthis virgata* (Cuvier and Valenciennes), and *Lutianus lioglossus* (Bleeker). From the gills of these fishes, three types of monogenetic flukes, representing three genera, were collected. Among them is a minute form which, in view of its taxonomic position and other considerations, is most probably the suspected parasite. It is a member of the genus *Ancyrocephalus* Creplin, 1839, and is, therefore, very closely related to the known pathogenic ectoparasitic trematodes of fishes in Europe and in the United States. It was present in predominating numbers on the gills of all the fishes examined. The infested organs were much congested and showed numerous punctiform hæmorrhages, produced no doubt by the hooks of the parasite.

ANCYROCEPHALUS MANILENSIS sp. nov. Plate 1, figs. 1, 2, and 3.

This is a very minute form, differing in that respect from other species of *Ancyrocephalus* and in particular from *A. teuthis* (MacCallum, 1915) Johnston and Tiegs, 1922, described

from *Teuthis hepatus*, a host that is related generically to one of the fishes from which the present parasite was collected. It further differs from *A. teuthis* in the extent of its vitellaria and in the shape of its ovary.

Description.[1]—Body elongate, 0.14 to 0.23 millimeter in length by 0.04 to 0.06 millimeter in width across testis; anterior end somewhat conical, with conspicuous lateral head lobes; posterior end of body proper more or less truncated, separated from caudal disc by a very slight constriction; cuticle smooth. On each side of the head, in the region of the cephalic lobes, are the terminals of three ducts, which are probably those of mucous glands that are commonly present in this group of trematodes, but the position of which could not be determined in the specimens available. Behind these duct terminals or immediately in front of the pharynx on each side of the median line, are two pairs of eyes, of which the posterior pair is larger. At the posterior end of the body is the caudal disc, 0.038 to 0.044 by 0.050 to 0.065 millimeter in size and provided with two pairs of principal central hooks and two pairs of minute marginal spines. The principal hooks are of almost the same characteristic shape (Plate 1, Fig. 2) and size, being about 0.045 millimeter in total length; they all terminate distally into fine recurved points, those of the dorsal pair being normally directed outwards and those of the ventral pair inwards. Each pair of hooks is joined together by a transverse piece; that of the dorsal pair is only slightly depressed in the center and that of the ventral pair is much bent and presents the appearance of an inverted yoke; each hook is supplied with a muscular bundle originating from the body proper.

Digestive system.—The mouth is a minute opening at the extreme anterior end; it communicates posteriorly through a narrow longitudinal passage with the relatively large pharynx. The latter is globular in shape, 0.013 to 0.017 millimeter in diameter, and located at about 0.030 millimeter from the anterior end. The œsophagus is very short, and divides immediately into two simple intestinal cæca that reach posteriorly to near the origin of the caudal disc.

Male reproductive organs.—The single testis is a relatively large, elongate organ, 0.035 to 0.040 by 0.020 to 0.030 millimeter

[1] The descriptions of this and the other forms dealt with in this paper are based on stained specimens that were killed and preserved without the use of pressure.

in size, located between the two intestinal branches immediately behind the equator of the body. The vas deferens is short and is dilated at about the middle of its length to form a sort of seminal vesicle; distally, it is modified into a copulatory organ, the ejaculatory duct, which, before reaching the common genital pore, passes through a roundish structure, the bulbus ejaculatorius. The common genital pore is in the median line, a short distance behind the intestinal bifurcation.

Female reproductive organs.—The ovary is equatorial in position, pretesticular, more or less round in shape, 0.017 to 0.025 by 0.017 to 0.020 millimeter in size. The uterus is short and opens beside the ejaculatory duct into the common genital pore. The vaginal opening is located on the right side at a level nearly equidistant between the pharynx and the ovary. The vitellaria are in the form of very minute and closely set follicles, located extracæcally for the most part and extending from the anterior level of the pharynx to the posterior limit of the intestines; anteriorly the vitelline glands of one side are separated from those of the opposite side, but posteriorly they are continuous. The transverse vitelline ducts and their reservoir are located on the dorsal surface at a level equidistant between the ovary and the bulbus ejaculatorius; the oötype complex is found immediately in front of this level. Only one egg is present in the uterus at a time and is usually not kept there long, for which reason the uterus is frequently encountered empty and collapsed. The egg (Plate 1, fig. 3) is asymmetrical in shape and about 37 by 28 microns in size; it is provided at one pole with a filament of variable length and diameter.

Specific diagnosis.—Ancyrocephalus: Very small, elongate, 0.14 to 0.23 by 0.04 to 0.06 millimeter in size; anterior end bluntly conical, with conspicuous cephalic lobes and containing the terminals of three pairs of ducts; posterior attaching disc well developed, not very sharply marked off from body, and supplied with two pairs of characteristically shaped central hooks and two pairs of marginal minor spines; ovary and testis median, at third fourth of body length, the former immediately in front of latter; ovary more or less globular in shape, 0.017 to 0.025 by 0.017 to 0.020 millimeter in size; testis elongate, 0.035 to 0.040 by 0.020 to 0.030 millimeter in size; copulatory organ with bulbus ejaculatorius; common genital pore median, immediately behind intestinal bifurcation; vitellaria separate anteriorly, continuous posteriorly, extending from anterior level

of pharynx to termination of intestines; egg asymmetrical, filamented, 37 by 28 microns in size.

Hosts.—*Teuthis virgata* (type host), *Lutianus lioglossus*, *Anyperodon leucogrammicus*.

Location.—Gills.

Locality.—Manila, P. I.

Type specimens.—Philippine Bureau of Science parasitological collection No. 49.

TETRANCISTRUM LUTIANI sp. nov. Plate 2, figs. 1, 2, 3, 4.

This parasite differs from *Tetrancistrum siguni* Goto and Kikuchi, 1917, the type and until now the only species of the genus, in being smaller, in the shape of its pharynx, which is globular instead of being elongated, and in having no lateral secondary intestinal cæca.

Description.—Body small, elongate, with three transverse constrictions; namely, an anterior one separating the head from the body proper, a middle one at or in front of middle of body length, and a posterior one separating the attaching disc from the body proper; length 0.40 to 0.50 millimeter, width across testis 0.14 to 0.17 millimeter; cuticle smooth. Anterior end with two pairs of lobes, into each of which leads a small duct probably from certain glands, the position of which could not be determined. At the posterior end is the attaching disc, which is transversely oval in shape and 0.038 to 0.040 by 0.070 to 0.080 millimeter in size; it is devoid of marginal spines, but is provided with two pairs of central hooks that are dissimilar in shape and size (Plate 2, fig. 3). The ventral pair of hooks average about 0.086 millimeter each in length and have distinctly biramous basal portions so that they appear asymmetrically V-shaped; they are connected together by a chitin piece, the extremities of which are rolled in. The dorsal pair of hooks average about 0.075 millimeter each in length and their basal portions are not biramous, their accessory pieces being short and almost stumpy; they are connected together by a slightly bent chitin piece.

Digestive system.—The small mouth is terminoventral in position and leads through a narrow passage into the globular pharynx. The latter is 0.040 millimeter in diameter and in moderately extended specimens is located about 0.050 millimeter from the anterior end. The œsophagus is very short. The intestinal cæca are simple canals; immediately behind

the testis they unite, after which they again separate and terminate blindly a short distance behind the point of their union.

Male reproductive organs.—The single testis is globular in shape, 0.104 to 0.107 millimeter in diameter, and is postequatorial and immediately postovarial in position, being partly overlapped in ventral view by the ovary. The sperm duct is short and somewhat dilated into a seminal vesicle before joining the chitinous penis; the latter is in the form of a double-walled, hollow, curved tube (Plate 2, fig. 2). The common genital pore is located in the median line, a short distance behind the intestinal bifurcation.

Female reproductive organs.—The ovary is transversely elongate, slightly arched, 0.060 to 0.070 millimeter across; it is immediately postequatorial and pretesticular in position. The uterus is short and opens outside through the common genital pore beside the male terminal organ. Immediately in front of the ovary, the uterus gives off a side branch, the vagina, that opens outside through an opening on the right side of the body, behind the level of the common genital pore. Only one egg is contained in the uterus at a time; it is of characteristic symmetrical shape, 50 by 55 microns in size and is provided at one pole with a filament of variable length and diameter (Plate 2, fig. 4); it is usually laid soon after it is formed, hence it is rare to find a worm with an egg in utero. The vitellaria are well developed, extending from the posterior level of the pharynx to behind the testis, thus surrounding the intestinal cæca more or less completely; they are continuous anteriorly and posteriorly.

The details of the excretory system were not worked out; only two terminal canals with their corresponding openings were observed; these are marginal in position, behind the posterior level of the pharynx.

Specific diagnosis.—Tetrancistrum: Body small, 0.40 to 0.50 by 0.14 to 0.17 millimeter in size; pharynx globular; œsophagus very short; intestinal cæca simple, devoid of lateral secondary cæca; caudal disc transversely oval in shape, 0.038 to 0.040 by 0.070 to 0.078 millimeter in size; caudal hooks dissimilar: ventral pair 86 microns long, asymmetrically V-shaped due to distinctly biramous basal portions and dorsal pair 75 microns long, with short accessory piece; egg symmetrical, filamented, 50 by 55 microns in size.

Host.—*Lutianus lioglossus.*

Location.—Gills.

Type specimens.—Philippine Bureau of Science parasitological collection No. 50.

MICROCOTYLE VIRGATARUM sp. nov. Plate 3, figs. 1, 2, 3.

This trematode resembles the large majority of the members of the genus *Microcotyle* P. J. van Beneden and Hesse, 1863, in being symmetrically shaped, but it differs from them in the extent of its intestinal cæca that reach into the posterior region of the caudal disc. According to the available literature, only *M. sciaenae* Goto, 1895, has intestines extending thus far posteriorly, but that species differs from the present form in being larger and asymmetrically shaped and in the possession of a larger number of posterior suckers.

Description.—Body elongate, tapering towards both extremities, 1.60 to 1.90 millimeters in length by 0.30 to 0.35 millimeter in maximum width; cuticle smooth. Caudal disc, 0.7 millimeter long or more than one-third of total body length, not very distinctly separated from body proper; it bears on both sides rows of minute suckers, forty-eight to fifty of them on each side and measuring about 0.030 by 0.045 millimeter. The structure of these posterior suckers (Plate 3, fig. 3) has been described by Goto (1895).

Digestive system.—The mouth is ventroterminal in position and contains in its cavity a pair of suckers. Each of these anterior suckers is oval in shape, 0.055 by 0.040 millimeter in size, and contains a membranous septum. The pharynx is very small, 0.023 by 0.027 millimeter in size; the œsophagus is very short, bifurcating immediately into two long intestinal cæca that extend to the posterior end of the body. Each intestinal cæcum contains, to as far as the beginning of the caudal disc or slightly beyond that level, both external and internal branches, which in turn contain secondary branches; in the rest of the region of the disc the cæca contain only primary external branches.

Male reproductive organs.—The testes are small transversely oval glands, 18 to 20 in number, arranged in two longitudinal rows in the middle of the second third of the body length. The vas deferens runs a slightly tortuous course in the median line from in front of the anterior testes to an S-shaped thick-walled organ, the penis, that leads into the common genital pore. The

latter is in the median line, in the center of a triangular genital sinus, about 0.15 millimeter from the anterior end.

Female reproductive organs.—The ovary is median, pretesticular, between the anterior and middle thirds of the body length; it is strongly arched, with one extremity rounded and larger than the other. The oviduct arises from the slender arm of the ovary, is directed posteriorly, becomes enlarged into an oötype into which the unicellular shell glands discharge their contents, makes a right-angled turn, gives off the genitointestinal canal, turns anteriorly and is continued as the uterus. The latter opens into the common genital pore beside the terminal male reproductive organ. The vaginal opening is in the median line, at about twice the distance from the anterior end of the worm to the common genital pore. The vaginal canal is short and soon divides into two posterior branches that become continuous with the principal vitelline ducts. The latter, continuing posteriorly, meet in the median line at the region of the ovary to form a relatively large, elongate vitelline reservoir, the duct of which joins the oviduct at about midway between the oötype and the point of origin of the genitointestinal canal. The vitellaria are in the form of minute follicles, extending from immediately behind the level of the common genital pore to some distance behind the testes; they are mostly lateral in position and surround the corresponding lengths of the intestinal cæca; anteriorly the glands of one side are separate from those of the other side, while posteriorly they are continuous.

Specific diagnosis.—Microcotyle: Body elongate, symmetrical, tapering towards both ends, 1.60 to 1.90 by 0.30 to 0.35 millimeter in size; caudal disc more than one-third of body length, not very distinctly separated from body proper; posterior suckers forty-eight to fifty in number on each side of disc; anterior suckers in mouth cavity each with membranous septum; pharynx small; œsophagus very short; intestinal cæca long, reaching to near posterior end of body, with external and internal branches; testes small, oval, eighteen to twenty in number, in two longitudinal rows, at middle third of body length behind ovary; penis S-shaped, thick-walled; common genital opening in center of triangular genital sinus, 0.15 millimeter from anterior end; ovary strongly bent, between anterior and middle thirds of body length; distance of vaginal opening from anterior end twice that from anterior end to common genital

pore; vitellaria separate anteriorly, continuous posteriorly, extending from immediately behind level of common genital pore to some distance behind testes.

Host.—Teuthis virgata.

Location.—Gills.

Locality.—Manila, P. I.

Type specimens.—Philippine Bureau of Science parasitological collection No. 51.

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ILLUSTRATIONS

[Drawn by Mr. V. V. Marasigan under the direction of the author.]

ABBREVIATIONS

as, anterior sucker.
bej, bulbus ejaculatorius.
cd, caudal disc.
du, terminal duct.
es, eye spot.
gic, genitointestinal canal.
gp. common genital pore.
h, hook.
int, intestine.
mo, mouth.
mu, muscle supplying hook.
ov, ovary.
pe, penis.
ph, pharynx.
ps, posterior sucker.
t, testis.
ut, uterus.
vd, vas deferens.
vid, vitelline duct.
vit, vitelline glands.
vo, vaginal opening.
vr, vitelline reservoir.

PLATE 1. ANCYROCEPHALUS MANILENSIS SP. NOV.

FIG. 1. Entire worm, dorsal view.
2. Caudal hooks, dorsal view.
3. Egg.

PLATE 2. TETRANCISTRUM LUTIANI SP. NOV.

FIG. 1. Entire worm, ventral view.
2. Penis, lateral view.
3. Caudal hooks.
4. Egg.

PLATE 3. MICROCOTYLE VIRGATARUM SP. NOV.

FIG. 1. Entire worm, ventral view.
2. Terminal portion of male reproductive system, showing penis, common genital pore, and genital sinus.
3. A posterior sucker.

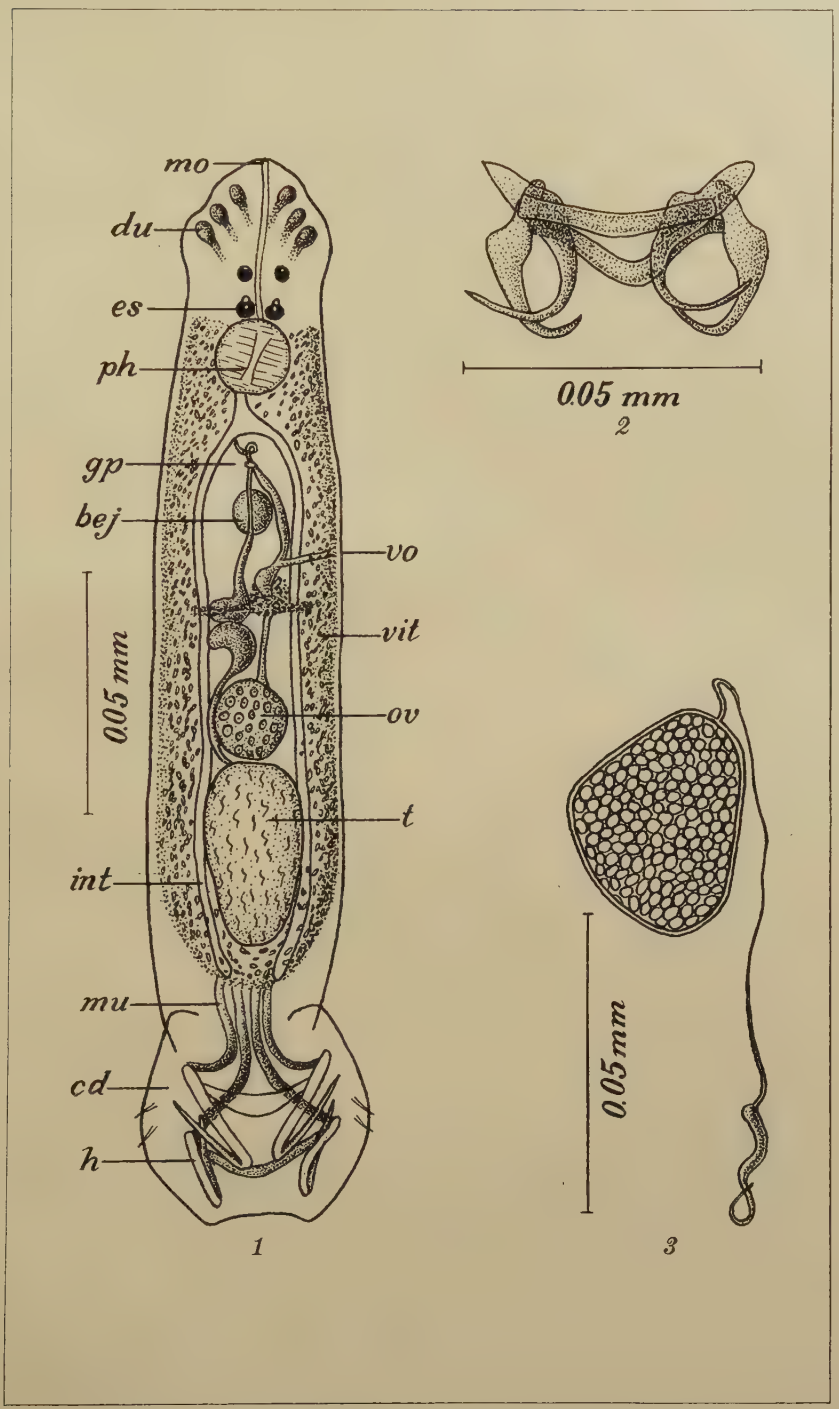

PLATE 1. ANCYROCEPHALUS MANILENSIS SP. NOV.

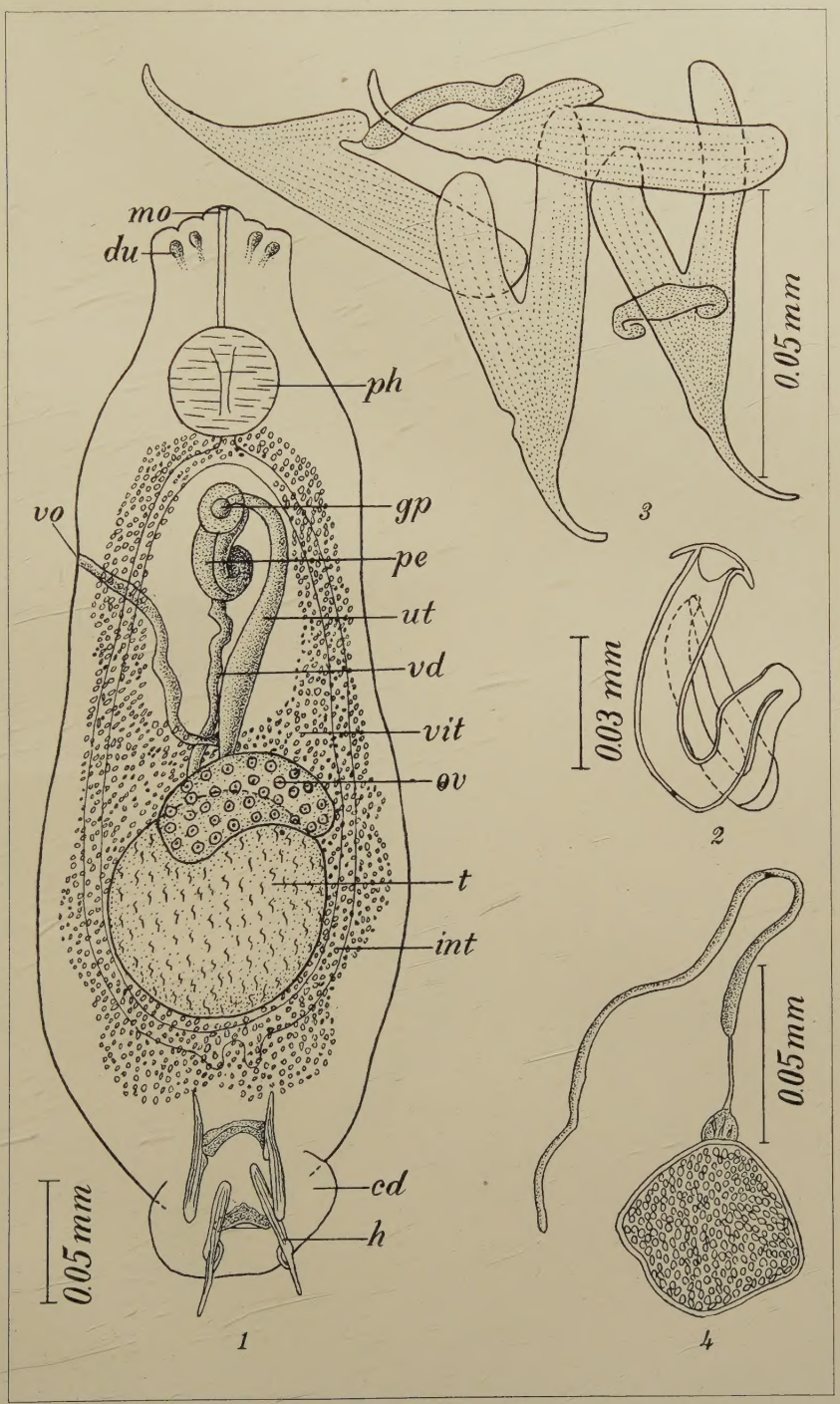

PLATE 2. TETRANCISTRUM LUTIANI SP. NOV.

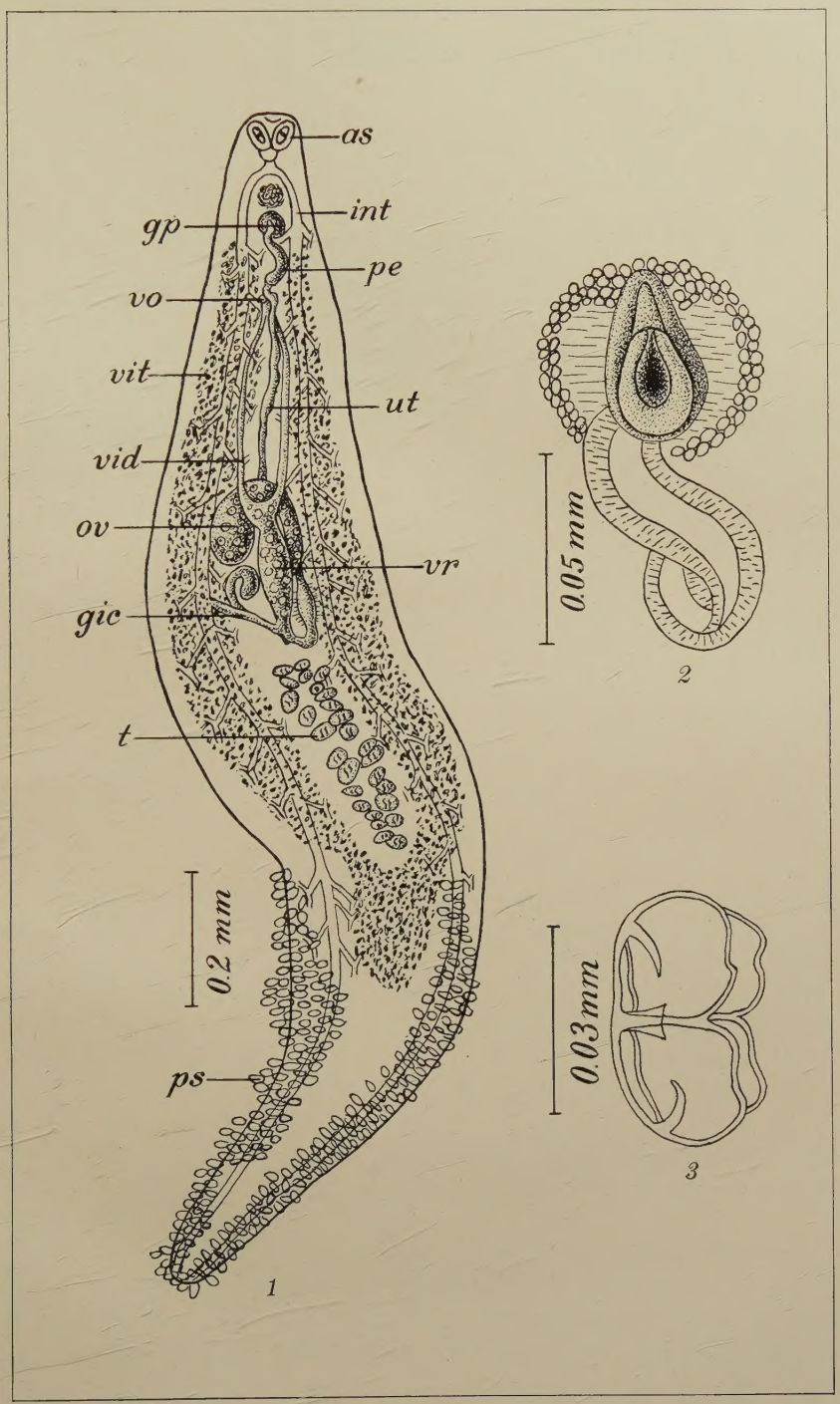

PLATE 3. MICROCOTYLE VIRGATARUM SP. NOV.